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Polar Continental Shelf Program **SCIENCE REPORT**

Logistical support for leading-edge scientific research in the Canadian Arctic

2014



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Polar Continental Shelf Program Science Report 2014: Logistical support for leading-edge scientific research in the Canadian Arctic

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Cover photograph: A student assesses the cliff-side nest of a Rough-legged Hawk on Bylot Island, Nunavut.

Section header image: Researchers conduct geological field studies at Lost Hammer Diapir on Axel Heiberg Island.

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Thermokarst terrain meets
a river delta on Bylot Island,
Nunavut.



The Polar Continental Shelf Program

Canada's North is a vast, diverse and endlessly beautiful region with a climate and remoteness that can be both exhilarating and challenging for those living and working there. For scientists conducting field studies or annual operations in the Canadian Arctic, the Polar Continental Shelf Program (PCSP) is a key support to scientists to ensure that their logistical needs are met with the highest level of efficiency and safety.

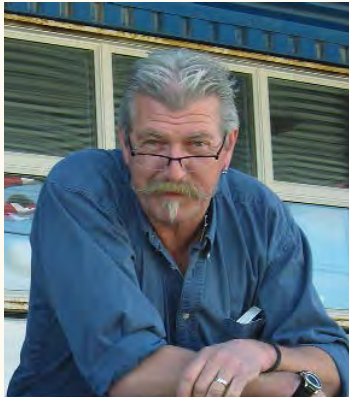
Established in 1958, the PCSP is highly experienced in providing logistical support for field studies that include up to 1,100 scientists,

students, field technicians and volunteers each year. The PCSP handles the chartering and dispatching of specialized aircraft required for field work; providing accommodations and laboratory space at its recently expanded facility in Resolute, Nunavut, from February to September each year; operating a communications network across all field camps receiving PCSP services; providing fuel for aircraft and camps; and lending field equipment.



The PCSP team at the
PCSP Ottawa warehouse

Spotlight on a PCSP employee: Tim McCagherty



Tim McCagherty
at the PCSP Resolute facility

Since 2008, Tim McCagherty has been one of PCSP's dedicated Logistics Operations Officers who ensure the smooth and safe running of PCSP field operations throughout the Canadian Arctic. This team develops the logistics plan for each field season during fall and early winter in Ottawa and implements the plan from the PCSP Resolute facility during the operational season (February to September).

Tim's work involves dispatching aircraft to and from remote field sites; ensuring client safety at field camps through twice-daily high-frequency radio and/or satellite telephone communications; and handling any issues that arise suddenly because of adverse weather and shipment delays. He also helps with search and rescue operations when required. Tim is exceptional at keeping track of the many moving parts of PCSP operations throughout the operational season and his friendly voice over the radio is a familiar sound to many researchers in the field.

Tim has been captivated by the Arctic since he first started working there, and his career in the North now spans more than 30 years. He appreciates the strong sense of community in the Canadian Arctic, where everyone seems to know each other and can easily turn to others for a helping hand. Tim's favourite place to visit in the North is Creswell Bay on Somerset Island in Nunavut, where wildlife abounds and it is "so quiet and so loud at the same time," as Tim says.

Helping researchers to make big discoveries and having the opportunity to share some of these findings with visitors to the PCSP Resolute facility are the components of Tim's job that he enjoys most. Tim is proud to be a part of PCSP's contributions to field research, whose results have benefits for all Canadians as well as importance to the scientific community. He has helped deliver logistical support to a broad range of research projects, including recent field work done in support of Canada's submission to the United Nations Convention on the Law of the Sea (UNCLOS) and the ongoing Geo-mapping for Energy and Minerals (GEM) program. Tim's expertise is integral to the PCSP's operations and to all those who depend on his work and that of the PCSP team every year to ensure a successful and safe field season.

"The challenge as a PCSP Logistics Operations Officer is being part of a small team that oversees operations with many moving parts across a massive dispatch area, often remotely managing them, but this is also part of the fun of the job."

– Tim McCagherty

A Twin Otter aircraft at Resolute

Highlights of the 2014 field season

- Total Arctic projects supported: **151**
- Arctic science projects supported: **124**
- Participants in PCSP-supported science projects: **869**
- Chartered aircraft hours flown: **4,557** (the equivalent of 190 days of non-stop flying!)
- Accommodations nights provided at the PCSP Resolute facility: **12,404**
- Meals served at the PCSP Resolute facility: **40,578**



The PCSP's Technical Field Support Services



This field camp at Castle Creek, British Columbia, included many pieces of PCSP equipment, such as the kitchen tent.

Established in 1930 as part of the Geological Survey of Canada (GSC), Technical Field Support Services (TFSS) has been an integral support for field work throughout Canada for 85 years. During that time, the equipment itself and inventory management have evolved with new technologies. The number and size of equipment shipments have grown over the years, as has the level of coordination required to manage operations. The field equipment warehouse has also changed locations in the Ottawa area, moving to its present location on Sheffield Road in 1995.

In 2007, TFSS was amalgamated with the PCSP. The equipment stores at the PCSP's Resolute facility and in Ottawa are now integrated into a single inventory, and clients have online access to view and order equipment. Equipment procurement follows a five-year plan, based on equipment life cycles and client feedback regarding new equipment needs and the results of testing new items in the field. Key support for field research teams is provided each year, helping them to plan and conduct their field studies effectively with well-maintained, reliable equipment.

Throughout its history, what has not changed is the commitment to providing clients with the right equipment to conduct their field work safely across the Canadian land mass. Denis St-Onge (Emeritus Scientist, GSC) first used TFSS's services in 1959 when he was planning his first field season in the Canadian Arctic as one of the PCSP's first researchers. Over the following decades, as he conducted GSC field work throughout Canada, TFSS supplied his team's equipment every year, including camp gear, tools, scientific equipment and a small trailer. TFSS employees always took meticulous care of the equipment, provided detailed instructions for its use, and made recommendations regarding equipment in the interest of safety and efficiency in the field. This attention to safety, equipment care and client satisfaction remains a top priority to this day.

In 2014, field equipment was supplied to 285 clients within 232 field projects across Canada. Field equipment is shipped, repaired, maintained and procured on an ongoing basis. For shipping equipment to field staging sites, each client's needs and shipping deadlines for each mode of transportation (e.g. air, truck, or ship) are considered. The current multi-million dollar inventory includes items such as camp gear, all-terrain vehicles, boats, satellite telephones, and health and safety items. Researchers working in the Canadian Arctic can request equipment during PCSP's Arctic logistics request period each fall. However, federal government departments may request equipment year-round for field locations anywhere in Canada and internationally, as needed.

Did you know?

The PCSP's TFSS held a two-day Field Equipment Showcase in February 2014 at the Ottawa warehouse. Clients were invited to visit equipment vendors who were on site, discuss their equipment needs and provide feedback regarding new items to consider for the equipment inventory. The PCSP is planning to host similar events in future.

Field equipment spotlight: The Logan tent

The Logan tent, named after Sir William Logan (first director of the GSC), has been a common site in field camps across Canada for decades. While most field equipment comes and goes as technology changes, the Logan tent has endured because of its durability, space and versatility.

With a single, central pole holding up canvas to create a triangular shape at the front and a small uplift of material at the back, the Logan tent is an unusual shape. However, this profile makes it unlikely to blow over in high winds, when the back of the tent is windward. These tents are easy to set up in bad weather, can comfortably house one to two people with their field gear, and can be set up with one or two layers of canvas, depending on weather conditions. Logan tents are often used as

sleeping quarters because a person can stand in them; they provide a comfortable amount of space, even with a cot; and hooks can be fashioned on the pole for drying items. They can be used for other camp purposes too, such as laboratory space. Perhaps the most important reason the Logan tent continues to be used frequently is its reliability to keep the weather out. When set up correctly, it is legendary for not leaking. The PCSP's equipment inventory includes more than 125 of these durable tents.

Logan tents have long been used in GSC camps:

1959 - Louise Fiord, Ellef Ringnes Island
1962 - Bathurst Inlet area
1970 - Tuktoyaktuk Peninsula
1973 - Sherard Bay, Melville Island
1985 - Wakeham Bay, Ungava Peninsula
1990 - Leaf River, Nunavik
1997 - McKellar Bay, Baffin Island
2009 - Cumberland Peninsula, Baffin Island
2014 - Back River, Chantrey Inlet area



Outreach events

Resolute School Science Fair

In May 2014, the Qarmartalik School in Resolute, Nunavut, held a science fair where students showcased their projects to their peers and the community. The science fair was designed as a motivational learning experience for the students, where the intermediate school students focused on projects about the human body and high school students focused on biomes. The PCSP helped to arrange for some PCSP-supported scientists who were staying at the Resolute facility to act as judges at this well-attended event.

Local residents discuss
Arctic science with a
researcher at the PCSP
Community Day.



Guests gather in the
PCSP Operations Centre.

Community Day at the PCSP Resolute facility

More than 100 people participated in a Community Day event at the PCSP Resolute facility on July 24, 2014. They learned about science projects through presentations in the PCSP Operations Centre and hands-on demonstrations in the Dr. Roy M. "Fritz" Koerner Laboratory by PCSP-supported scientists. Participants also enjoyed a throat singing performance, ate locally made bannock and joined in a barbeque lunch. The children especially enjoyed the kids' craft area and a visit from the Natural Resources Canada (NRCan) mascot, NRCat. Community Day provided an opportunity for the PCSP, residents of Resolute and scientists to interact and learn from each other about Arctic research, the logistics required for field studies and important northern scientific issues.





The PCSP Arctic Field Camp display at the 2014 Winterlude Cool Science Saturday

Winterlude “Cool Science Saturday” in Ottawa

As part of annual Winterlude celebrations in Ottawa, the PCSP participated in the family-friendly “Cool Science Saturday” event on February 15, 2014. The PCSP set up an Arctic field camp, using equipment from the field equipment inventory, for members of the general public to explore. Visitors to the camp had the opportunity to experience what a northern field camp would feel like and to ask PCSP staff about PCSP-supported field work. This kind of outreach is important for helping those not familiar with northern research to learn about the work that is taking place in the Canadian Arctic and why it is important to the country and beyond.



ArcticNet Annual Scientific Meeting 2014

ArcticNet (a member of the Networks of Excellence of Canada) and the PCSP work together, whenever possible, to help researchers with their logistical needs in the North. The PCSP is involved with the ArcticNet scientific meeting each year, where the PCSP has the opportunity to discuss operations, field season needs and ongoing Arctic science with past, current, and prospective clients, government officials, and other national and international polar organizations. At the 2014 ArcticNet meeting held in Ottawa, the PCSP hosted an information booth for delegates to learn about PCSP operations and supported science.



A local resident receives a book from the PCSP's Director General for winning a contest as part of children's activities at the PCSP Community Day.

NRCat shows some geological rock sampling pails that are part of the field equipment stores at the PCSP Resolute facility.

Connections to other Arctic organizations

The Canadian High Arctic Research Station and the Canadian Polar Commission

The Canadian High Arctic Research Station (CHARS) is a new, world-class research facility that is being built in Cambridge Bay, Nunavut. The station will complement and anchor the existing strong network of northern research facilities in Canada. The facility is scheduled to open in 2017, but research has already begun through the CHARS science and technology program.

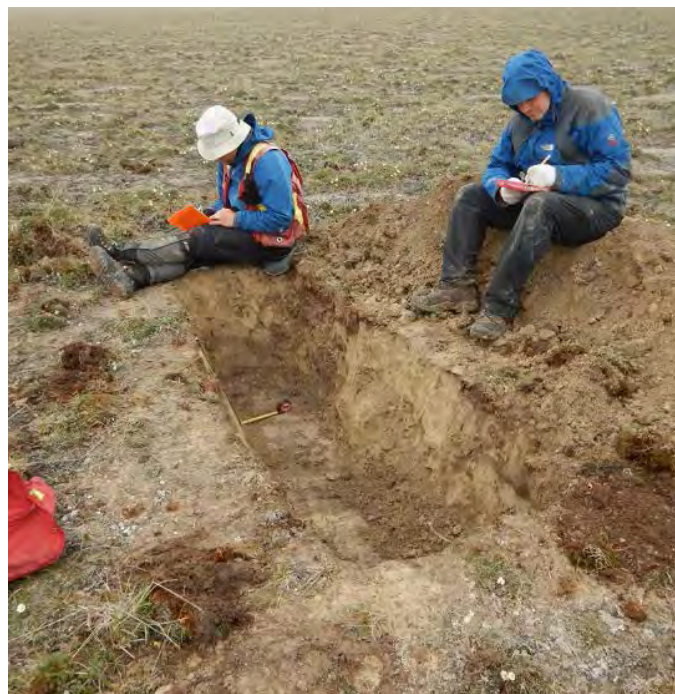
The steel structure of the CHARS Field and Maintenance Building is under construction in Cambridge Bay, Nunavut.



Researchers conduct soil studies as part of a CHARS tundra ecosystem classification and mapping project.

The *Canadian High Arctic Research Station Act* (the Act) received royal assent in December 2014. This act will merge the mandate and functions of the Canadian Polar Commission (CPC), Canada's main polar knowledge agency, with those of the Canadian High Arctic Research Station and its science and technology program. The new organization will manage the station and its national Arctic research program while continuing the advisory, facilitation and engagement roles of the CPC.

The PCSP will coordinate terrestrial field logistics for the CHARS science and technology program. CHARS-supported scientists will have access to the PCSP's logistical services and field equipment. The efficiencies gained through this partnership will benefit scientists as well as the Government of Canada.





Geo-mapping for Energy and Minerals

The GEM program at NRCan is helping to determine the mineral and energy potential of Canada's North through increased geological knowledge of the region. The program continues to provide geoscience knowledge that has been instrumental to making informed resource investment and land-use decisions in the North. The second phase of this program, GEM-2, began in 2013 and will run until 2020. In the first field season (2014) of the GEM-2 program, the PCSP provided logistical support for 10 projects across all three territories and northern Quebec, as well as field equipment to projects in northern areas of Newfoundland and Labrador and British Columbia. The PCSP will continue to provide logistical support to GEM scientists throughout the second phase of the GEM program. The GEM-2 program builds on the successes of the first phase (2008–2013) that resulted in more than 840 new maps and reports and a wealth of data that is publicly available.

Canadian Armed Forces Arctic Training Centre

Under a 25-year agreement signed in 2010, the PCSP is providing Arctic logistics and field equipment to the Canadian Armed Forces Arctic Training Centre (CAF ATC), a Northern Strategy commitment. The PCSP completed a \$21 million expansion to its Resolute facility,

financed by the Department of National Defence (DND), to add additional accommodations and working space. The expansion also upgraded key communications infrastructure. The expansion and the provision of logistics support to DND has helped to optimize the limited infrastructure in the Arctic and increased support to researchers, including enabling science during the dark season and improving radio and satellite communications. In 2014, the PCSP provided logistical support for nine CAF ATC projects.

Geologists examine an outcrop of sedimentary rocks near Darnley Bay, Northwest Territories.

A snowmobile patrol travels near Resolute during Canadian Forces training activities in Nunavut.



Did you know?

The PCSP is a member of the Canadian Network of Northern Research Operators (CNNRO), which acts as a forum for operators of Arctic and subarctic research facilities to share information and develop collaboration in order to improve operational and cost efficiencies.

Volunteers: Key helpers in Arctic research

Several PCSP-supported projects include volunteers on their field teams. These individuals give their time and effort to research projects out of interest in science, for the opportunity to experience the Arctic and for sheer enjoyment. Their work helps many projects complete their field studies efficiently and in a cost-effective way, while enriching the field experience for the whole team. This “win-win” situation is the main reason scientists such as Jennie Rausch (Environment Canada, Yellowknife) bring volunteers into the field every summer.

To reach the capacity needed to fulfill all field work roles within a set budget, Rausch’s field team has recruited one or two volunteers each year since 2003 to help with annual shorebird monitoring studies. Volunteers assist with bird surveys, nest searches and vegetation sampling. This research contributes to the Arctic component of the Program for Regional and International Shorebird Monitoring (Arctic PRISM), which aims to develop and monitor Arctic-wide shorebird population estimates for most North American shorebirds.

The volunteers on Rausch’s field team have included artists, scientists, non-governmental organization employees, retirees, high school and prospective graduate students, teachers, and federal government employees. Many of these volunteers take leave from their schools or jobs to join the field team for two to eight weeks. The outside perspective brought by volunteers is important to the science being done and reinvigorates

the field crew about the science they do and the incredible places where they work.

Volunteer Adam Fritz was part of shorebird studies with Rauch’s team on Victoria, Melville, Prince Patrick, and Bathurst Islands in 2012 and 2014. As the manager of Northern Affairs in Environment Canada’s Strategic Policy Branch in Ottawa, Fritz must have a broad understanding of his department’s activities, interests and needs in the Canadian Arctic. He jumped at the chance to experience northern field work. As Fritz says, “Apart from the value this experience would provide me in being able to do my job effectively – building my network, learning more about Environment Canada’s science activities, and giving myself on-the-ground experience in the Arctic – I was thrilled at the opportunity to travel to the High Arctic.”

The challenges of weather, mud and wildlife helped Fritz better understand what northern researchers go through to collect data and what Environment Canada’s Arctic scientists require to succeed at their work. This information is particularly useful for helping him to discuss his department’s northern research with senior management. Fritz was also inspired from his experiences to write a storybook for his children about Lego® characters doing Arctic field work and learning about the North. This book is now a useful and entertaining outreach tool for shorebird biologists and the PCSP. From a personal perspective, Fritz says, “Finding muskox skulls littering the tundra, holding tiny shorebirds that somehow manage to survive in the harsh environment and making new friends in my fellow volunteers and research colleagues will be memories that I will cherish forever.”

Adam Fritz helps with a shorebird survey on western Victoria Island, south of Ulukhaktok, Northwest Territories, in 2014.

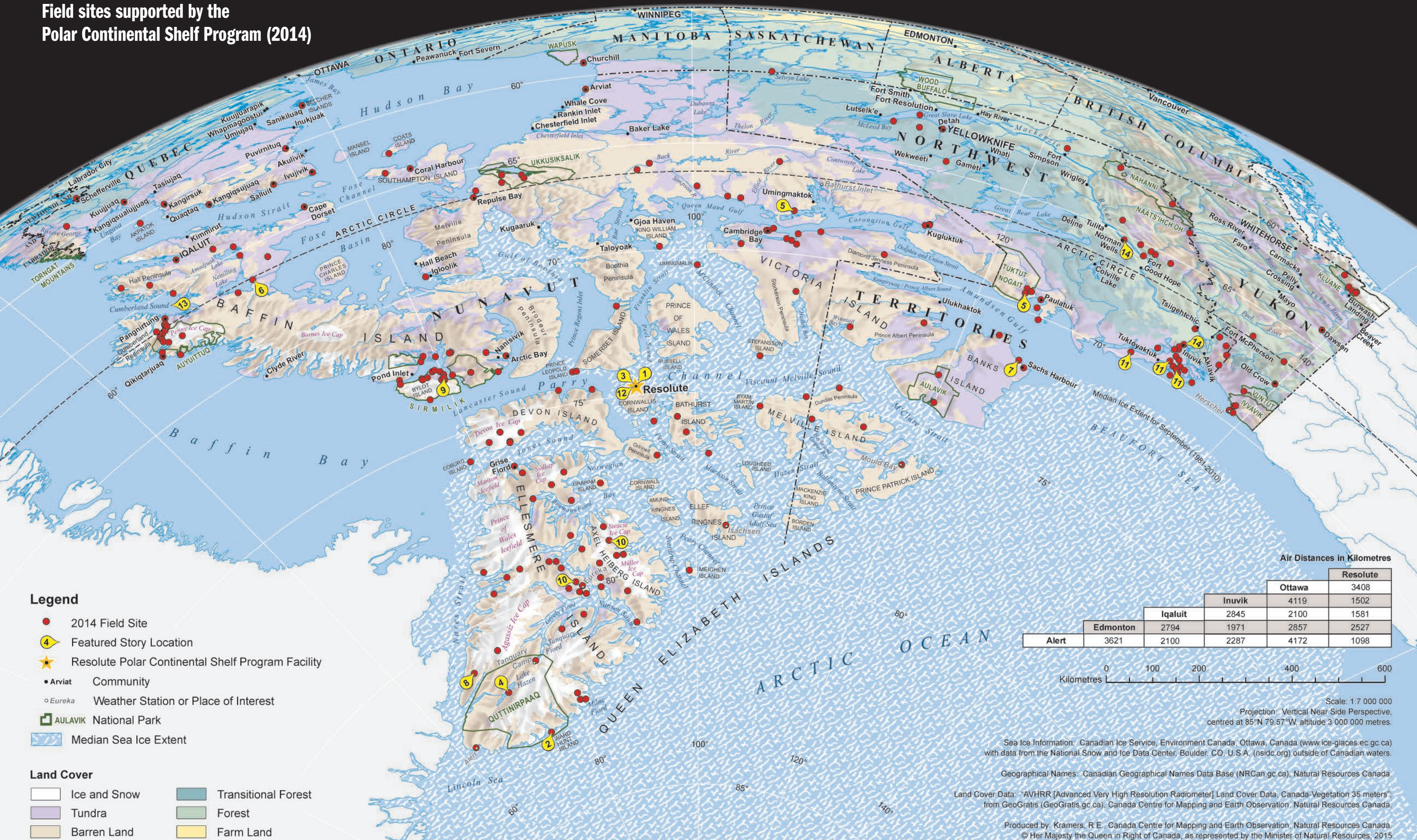
“Bringing in new people fresh to the field work helps me see how I could do things better, what parts of my program general Canadians can relate to, what I could be doing better in terms of spreading the word on the work we’re doing, and, in general, reminding me of the bigger picture.”

- Jennie Rausch



Wildflowers on Herschel
Island, Yukon

Field sites supported by the
Polar Continental Shelf Program (2014)





A field camp in
Brock River Canyon,
Northwest Territories.



PCSP-supported projects in the Canadian Arctic

In 2014, the PCSP provided logistical support to 141 Arctic science and operations projects in a broad range of social and natural science disciplines. These studies took place throughout all three territories and northern areas of Newfoundland and Labrador, Quebec and Manitoba. Projects were conducted by researchers from 25 Canadian universities, 12 federal and territorial government departments and agencies, and 14 northern, international or independent organizations. The work of PCSP-supported researchers is contributing to increased knowledge of the Canadian Arctic and informing discussions of key northern issues.

Student research

The PCSP is pleased to help the next generation of Arctic researchers gain valuable northern field work experience. In 2014, more than 300 high school, college and university students had the opportunity to experience Arctic field work through PCSP-supported projects. The following stories highlight four student research projects. Note the featured story location number to locate each student's study site on the report's map.

Parks Canada staff and volunteers unload field gear from a helicopter sling beside the Alsek River in Kluane National Park and Reserve, Yukon.



Bioaccessibility of contaminants in traditional food: Dietary practices and the gut microbiome

Catherine Girard (Université de Montréal, Centre for Northern Studies)

Supervisors: **Marc Amyot** and **B. Jesse Shapiro** (Université de Montréal)

Featured story location on map: 1

Certain environmental contaminants can bioaccumulate (increasingly concentrate up the food chain), resulting in high levels of contaminants in larger animals. When meat from these animals is consumed, contaminants can be absorbed and potentially pose health risks, particularly to northern residents who often have diets rich in traditional foods such as seal. Knowledge of contaminant breakdown in the gut (gastrointestinal tract), particularly the role of the gut microbiome (bacterial community living in the gut), is limited, especially in Aboriginal populations.

Catherine Girard's doctoral research focuses on understanding the digestion of contaminants and what factors influence their bioaccessibility (the potential to be digested and absorbed). Her project is characterizing the gut microbiome of

a representative group of residents in Resolute, Nunavut, and detailing their dietary practices to assess contaminant digestion and absorption processes. These results will be compared to those of a second study group, composed of residents from Montréal, to assess differences in contaminant absorption by different populations.

Two Resolute residents have provided vital field work assistance to Girard, helping to recruit participants, conduct interviews and collect samples. Through interviews, Girard learns what traditional foods are most commonly consumed and how they are prepared. In her university laboratory, she uses stool samples collected from participants to determine the gut bacteria communities in each study group and runs food samples through a simulated gut to examine digestion. The results from both study groups are then compared to understand how traditional diets, cooking techniques and the gut microbiome of the Resolute study group influence contaminant breakdown and absorption.

Preliminary results suggest that certain cooking practices and types of drinks consumed with fish can reduce methylmercury bioaccessibility. Girard has presented her work at the 2012 and 2013 PCSP Resolute Open House events and she will be providing a detailed report about the project's results to the community of Resolute at the project's completion. This study's findings will improve understanding of contaminant absorption from northern diets and, potentially, how to reduce it.

Admiring the view over
Meretta Lake and Allen
Bay near Resolute,
Nunavut.



"This project will allow for a greater comprehension of the digestion and absorption of contaminants and will contribute to current models that inadequately describe these processes in Inuit populations."

– Catherine Girard

Landscape and water interactions in the Ward Hunt Lake watershed

Michel Paquette (Université de Montréal, Centre for Northern Studies)

Supervisors: **Daniel Fortier** (Université de Montréal) and **Warwick Vincent** (Université Laval)

Featured story location on map: 2

Michel Paquette's doctoral research is part of a collaborative project examining geomorphology, aquatic ecology and environmental change along the northern coast of Ellesmere Island in Nunavut. This area has seen dynamic cryosphere (the ice components of the environment) responses to changing climate conditions in recent years, including ice shelf breakup events and full summer melting of thick lake ice cover that has historically been present year-round. The extreme polar desert environment of this study area allows researchers to examine the limits of ecosystem functions and permits comparisons to similar environments in Antarctica.

Paquette's study seeks to improve understanding of slope changes in the Ward Hunt Lake watershed on Ward Hunt Island (north of Ellesmere Island) and their links to sediment and nutrient inputs to the lake, which influence aquatic habitat and organisms. He has done surveys to measure snow depth, density, and melt rates; used ground-penetrating radar to collect lake bathymetry and ice thickness data; installed soil temperature and moisture sensors to monitor permafrost as part of the Arctic Development and Adaptation to Permafrost in Transition (ADAPT) program; detailed water tracks (subsurface flow paths within the active layer of permafrost soils); and sampled water and soils from water tracks for data on nutrients and sediment carried toward the lake.

Paquette's initial findings suggest that water tracks behave similar to typical streams, flowing and carrying sediment following a daily cycle

during the melt season. He will build on these results by characterizing how water track and broader landscape processes change over time in this extreme environment, as well as their effects on Ward Hunt Lake.

Measuring electrical conductivity in a water track on Ward Hunt Island, Nunavut.



Collecting drinking water from Ward Hunt Lake, Nunavut.

"Field work is just great. Where else do you have the opportunity to integrate your literature knowledge to discuss hypotheses while also having to repair a broken engine in the middle of the polar wilderness?"

- Michel Paquette

Methylmercury dynamics in Arctic freshwater ecosystems

Gwyneth MacMillan (Université de Montréal)

Supervisors: **Marc Amyot** (Université de Montréal) and **John Chételat** (Environment Canada)

Featured story location on map: 3

Searching for
zooplankton in a
High Arctic Pond near
Resolute, Nunavut.

Gwyneth MacMillan is part of a research team that is studying the effects of climate on the transport, transfer and accumulation of methylmercury in northern lakes and ponds. Methylmercury is a highly toxic pollutant that can build up in the food chain, potentially causing mercury exposure to humans when they consume meat from traditional foods such as fish and seal. For her doctoral research, MacMillan is assessing the effects of climate on methylmercury movement and accumulation in zooplankton (tiny invertebrates near the bottom of the food chain), the movement of this pollutant up the food chain to fish and the factors that influence these processes.

MacMillan has collected lake bathymetry data, in addition to water samples for water chemistry and zooplankton analyses, at study

sites representing three distinct natural regions: subarctic taiga (northern boreal forest) near Kuujjuarapik-Whapmagoostui, Quebec; Arctic tundra near Iqaluit, Nunavut; and High Arctic polar desert near Resolute, Nunavut. Northern residents, including two students from Nunavut Arctic College, provided valuable field assistance for the project, including helping to identify and access remote study sites and collect samples.

Preliminary results from MacMillan's research suggest that methylmercury concentrations in zooplankton in Arctic lakes near Iqaluit and Resolute are significantly lower than in populations at subarctic study sites. She plans to examine environmental controls of mercury accumulation in the food chains of northern lakes and ponds to improve the prediction of climate change impacts on the mercury cycle. She has presented her research at the 2014 PCSP Resolute Community Day event, a community outreach event in Kuujjuarapik-Whapmagoostui and a children's science camp at Nunavut Arctic College in Iqaluit.

MacMillan has also participated in a related multi-year study on thaw ponds near Kuujjuarapik-Whapmagoostui and on Bylot Island, Nunavut. Thaw ponds are small, shallow water bodies that form because of permafrost thaw and are now one of the most common types of aquatic systems in the rapidly changing North. This study has found that eastern Arctic thaw ponds have very high concentrations of methylmercury.



"The latitudinal gradient of this study will allow us to identify and better predict how climate change may influence the transport, transformation and transfer of mercury in Arctic lakes and ponds."

– Gwyneth MacMillan

Climate change impacts on the health and productivity of Lake Hazen, Nunavut

Kyra St.Pierre and **Lisa Szostek** (University of Alberta)

Supervisor: **Vincent St.Louis** (University of Alberta)

Featured story location on map: 4

Kyra St.Pierre's doctoral research is part of a broader project to quantify the ongoing impacts of climate change on High Arctic watersheds (the area from which water flows into a lake) and their ecosystems, focusing on Lake Hazen in Quttinirpaaq National Park on Ellesmere Island, Nunavut. Increased glacier surface temperatures in the lake's watershed have been documented in recent years. Environmental responses to this warming include substantial increases in glacial meltwater and sediment input to the lake and reduced duration of lake ice cover each year. St.Pierre's project focuses on determining the impacts of changing watershed processes, such as snowmelt, glacier melt and terrestrial productivity (the rate that biomass is created on land) on water quality and productivity in Lake Hazen.

For her 2014 field work, St.Pierre was accompanied by a field assistant, Lisa Szostek, an undergraduate student. By examining snow on the lake ice and snowmelt runoff, they assessed the types and amounts of environmental contaminants being transported to the lake. They also studied water chemistry through the lake's 265-metre (m) water column to examine the contributions of snowmelt to nutrient and contaminant levels at various depths. Sediment cores were also collected to study productivity in the lake bottom by measuring sediment characteristics such as oxygen and the presence of microbial communities (microscopic organisms).

St.Pierre's preliminary results suggest that snowmelt can alter the chemistry of the lake water just below the ice because melting snow releases wind-blown dust into the lake and causes an increase in water contaminants. Further data analysis will expand on these findings and identify influences of changing watershed processes on Lake Hazen's ecosystem. The results of this research will help to improve understanding of future impacts of changing environmental conditions on water supplies, which are vital to northern communities.

Packing a cooler during snow sampling on Lake Hazen, Ellesmere Island.



"Given the importance of freshwater resources to the health and well-being of northern communities, understanding the effects of climate change on High Arctic freshwaters is imperative."

– Kyra St.Pierre

Scientific research projects

The following stories highlight some of the leading-edge science being conducted by PCSP-supported scientists across the Canadian Arctic. Note the featured story location number to locate each researcher's 2014 study site(s) on the report's map.

Geological mapping and thematic studies of Brock Inlier, Northwest Territories, and Elu Basin, Nunavut

Rob Rainbird (Natural Resources Canada)

Featured story location on map: 5

NRCan's GEM program is laying the foundation for sustainable economic development in Canada's North through improved, publically available, geoscience knowledge and mapping of this vast region. As part of the second phase of this program, Rob Rainbird is leading studies involving detailed stratigraphic (sedimentary rock layer) analyses and bedrock geological mapping of middle to late Proterozoic (1,600-million- to 800-million-year-old) sedimentary rocks in two areas with mineral resource potential and limited geological information. The research team includes scientists from the GSC and the Northwest Territories Geological Survey, as well as university collaborators and students.



Rob Rainbird's field team examines rock layers in the wall of Brock River Canyon, Northwest Territories.

The first project focuses on the Brock Inlier, which contains mostly late Proterozoic sedimentary rocks surrounded by younger sedimentary rocks and is located just east of Darnley Bay, Northwest Territories. The Brock Inlier also contains the largest gravitational and magnetic anomaly (an abnormality in geophysical measurements) detected in North America, which indicates dense rocks below the surface that may contain metals. Because some of this project's field work is conducted within Tuktut Nogait National Park, the research team coordinates with Parks Canada for field studies and provides data for interpretive information about the park.

The second project is focused on the Elu Basin, located in the Kitikmeot region of Nunavut. This study area, last mapped in the 1970s, is underlain mostly by middle Proterozoic sedimentary rocks. The basin is approximately the same age as similar rocks in the region where valuable deposits of uranium have been discovered. The research team is identifying unconformities (a contact between layers of rock that indicates erosion) under ancient river deposits to determine the potential for uranium resources in the Elu Basin.

For both projects, the research team uses high-resolution satellite imagery, photographs and ground-truthing (verifying in person what is seen on imagery) to learn about the spatial extent and composition of rock units of particular interest. During 2014 field work on Brock Inlier, they examined excellent exposures of Proterozoic sandstone, which is allowing them to learn more about ancient river processes. They also found rock units in parts of the Brock Inlier area that had been mapped incorrectly in previous studies. They

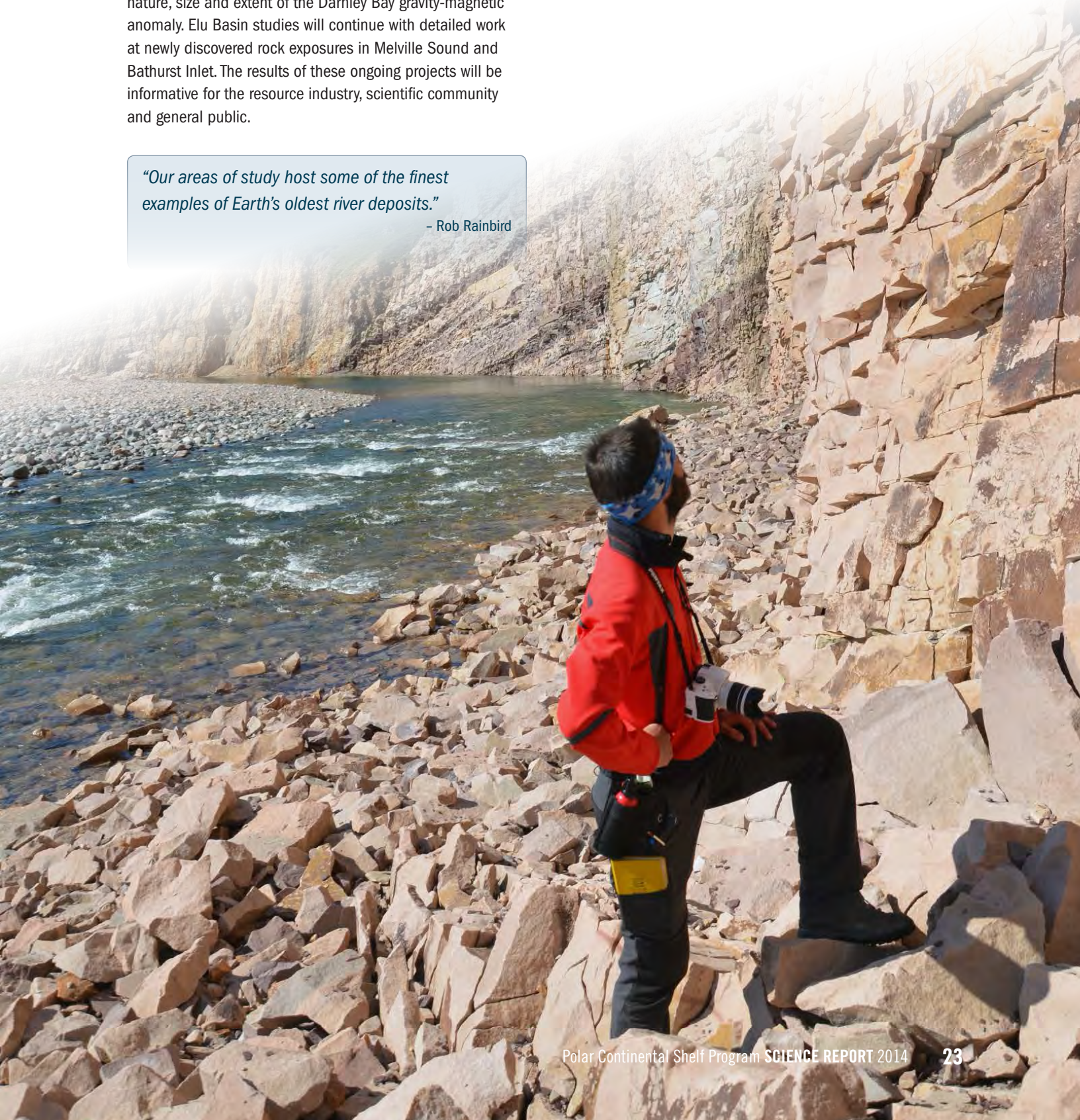
will use data from this project to produce modern GSC Open File maps, activity reports and other research publications.

The research team will continue their work on the Brock Inlier, which may involve a geophysical survey to trace rock layers from the surface to the subsurface and to understand the nature, size and extent of the Darnley Bay gravity-magnetic anomaly. Elu Basin studies will continue with detailed work at newly discovered rock exposures in Melville Sound and Bathurst Inlet. The results of these ongoing projects will be informative for the resource industry, scientific community and general public.

“Our areas of study host some of the finest examples of Earth’s oldest river deposits.”

– Rob Rainbird

A researcher examines the stratigraphy of a sandstone wall along Brock River Canyon.



Long-term monitoring of Nettiiling Lake, central Baffin Island, Nunavut

Reinhard Pienitz (Université Laval, Centre for Northern Studies)

Featured story location on map: 6

Lake sediments can provide long-term paleoclimate (past climate) records that can be used to place recent observed climate changes into context and help forecast future conditions. Reinhard Pienitz and his research team are using lake sediment records to reconstruct the climate history of the Foxe Basin region of Nunavut. Such records are limited in this area, which lies in a transitional position between High Arctic areas that are seeing stronger changes in environmental conditions in recent decades and eastern subarctic areas that have experienced more stable conditions.

The research team has completed work on 15 lakes on Southampton Island, the Melville Peninsula, the Foxe Peninsula and Baffin Island since 2004. Their recent focus has been on Nettiiling Lake, Baffin Island, which is the largest freshwater ecosystem of the Canadian Arctic Archipelago. They have examined the physical, chemical and biological characteristics of lake sediment cores from various depths to determine the climate history of the study area since the end of the last ice age. The team has also collected water samples to understand and monitor the current state of this huge freshwater ecosystem.

Through this work, Pienitz and his collaborators have developed a new type of proxy (indirect) climate record that uses oxygen isotopes (different forms of oxygen) from microscopic algae fossils (diatoms) in the lake's sediments. The cell structure of diatoms reflects water chemistry when they lived. Consequently, their fossils can provide a record of environmental conditions, as shown through fluctuations in the amount of the oxygen-18 isotope present in the fossils. This novel approach to oxygen isotope records has allowed the team to reconstruct lake conditions (water salinity and temperature) and the air temperature of the study area back to when the lake was connected to the ocean, prior to post-glacial uplift of the land. The diatom oxygen isotope record also complements and corroborates the other proxy records of environmental changes developed from the sediments of Nettiiling Lake. These proxy records include a record of past lake conditions indicated by changes in diatom assemblage composition (types and abundances of diatom species).

Recent results of this study confirm and add detail to the documented history of deglaciation and subsequent land uplift of southwestern Baffin Island. These paleoclimate records also show strong correspondence with documented melt rates from nearby Penny Ice Cap. Pienitz plans to develop a larger regional network of study sites to document past climate variability in the Foxe Basin area. This research will allow for comparisons to be made with paleoclimate records from other regions to examine differences and causes of climate variability over time. It will also provide useful information for modelling climate and understanding potential changes to northern freshwater bodies in the future.

"Knowledge of how these fragile ecosystems respond to natural and human pressures will allow us to be better prepared for and adapt to climate change and put us in a better position for well-informed decision-making with respect to sustainable development in the North."

– Reinhard Pienitz



Researchers prepare to do sediment and water sampling work on Nettiiling Lake, Baffin Island.

Archaeological investigations of past hunting landscapes on Banks Island, Northwest Territories

Lisa Hodgetts (University of Western Ontario)

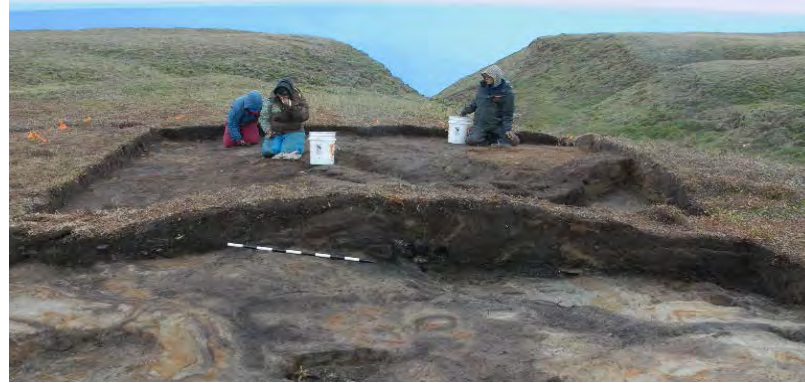
Featured story location on map: 7

Ancient artifacts and dwellings used by ancestors of today's Inuit can be found throughout Canada's North and are invaluable for understanding the region's cultural history. For several years, Lisa Hodgetts and her students have been conducting archaeological and Inuvialuit traditional knowledge research on Banks Island, Northwest Territories, to document and examine human use of the area since its initial occupation almost 4,000 years ago.

While much is known about Thule people's use of the Mackenzie Delta 400 to 500 years ago, their use of Banks Island, and connections between both areas at that time, are not well understood. To fill these knowledge gaps, Hodgetts' team is examining human activities at a large archaeological site that was used by Thule people around 1500 to 1600 A.D. In 2014, Hodgetts and her field team, which included two high school students from Sachs Harbour, excavated a dwelling at a site that is 30 kilometres (km) east of Sachs Harbour and was chosen for study through community consultation.

The dwelling is a sod-walled structure with a dirt floor known as a *qarmat*. Hunting tools, ulu fragments, and coils of sinew for sewing, were found in and around the *qarmat*, along with a large collection of animal bones from Arctic char, caribou, muskox, seals and belugas. An unexpectedly high number of fox remains were also found. The bones and artifacts at the dwelling suggest that the site was used in fall to prepare hides and clothing for winter and, possibly, stockpile them for trading. DNA and isotope analyses of the animal remains will be used to reconstruct fluctuations in animal population sizes, diets and ranges, as well as confirm the time of year that people used the site. The team has also collected animal bones in Aulavik National Park to develop a regional perspective for the DNA and isotope studies.

The team's ongoing Inuvialuit traditional knowledge research involves working closely with the community of Sachs Harbour to use interviews to document elders' knowledge of the excavated dwelling and its artifacts, as well as traditional



Lisa Hodgetts's field team excavates a *qarmat* on Banks Island.

hunting areas, animal movements and archaeological sites on Banks Island. In 2014, the team also videotaped traditional knowledge shared by elders during trips to locations of interest around the island. This collaborative research will result in a website that integrates archaeological findings and Inuvialuit traditional knowledge to document the human history of Banks Island.

Community consultation and involvement is integral to this project. Hodgetts' team communicates with the community at all stages of its research and, at the end of each field season, the team shares findings and provides opportunities for residents to hold artifacts. The team is currently preparing artifact replicas for the community and is developing a project website to showcase 3D digital models of artifacts for all to view.

Did you know?

Different types of ancient Arctic dwellings leave distinctive mounds and pits where they are buried. For example, a typical Thule winter home would appear on the ground surface as a donut-shaped mound with a depression where an entrance tunnel was.

"Many of the families in Sachs Harbour today first came to Banks Island in the early 20th century to trap foxes. This dwelling indicates that fox skins were also important to the island's earlier occupants."

– Lisa Hodgetts

The early evolution of vertebrates and arthropods

Neil Shubin (University of Chicago) and **Ted Daeschler** (Academy of Natural Sciences and Drexel University)

Featured story location on map: 8

The early evolution of animals largely remains a mystery in the field of paleontology (the study of ancient life). The Paleozoic Era (541 to 252 million years ago) is a time of particular interest, when vertebrate (back-boned) life originated and diversified into many types, forming the foundation of present day vertebrate diversity. Since 1999, Neil Shubin and Ted Daeschler have been leading studies to find and document Paleozoic fossils across the Canadian Arctic Archipelago to improve understanding of evolutionary changes that led to important innovations in the history of life, including those that led to the earliest animals with limbs.

Shubin and Daeschler's research team has discovered many fossils, including several from rocks of the Late Devonian epoch (385 million to 359 million years ago), when tetrapods (four-legged creatures) first appeared and the current Canadian Arctic was part of a land mass near the equator. The late Farish A. Jenkins, Jr. (Harvard University) played an important role in many of the team's fossil discoveries, including *Tiktaalik roseae* from Ellesmere Island, Nunavut. This Late Devonian transitional creature had features of both fish and tetrapods and lived in a river environment. Since

2004, the team has found several partial *Tiktaalik* skeletons, which has allowed them to reconstruct substantial portions of the animal's body and identify key evolutionary traits.

Tiktaalik had a mobile neck and both early lungs and gills. Also, its shoulder areas, ribcage structure and limb-like fins could have supported its body weight out of water. These traits enabled this creature to live in shallow water and, potentially, on land. The team continues its work on *Tiktaalik* fossils to develop further understanding of its body structure. Once the team completes its analyses, the fossil specimens will be added to the research collections at the Canadian Museum of Nature in Ottawa, on behalf of the Government of Nunavut.

More recently, the team discovered partial skeletons of another Late Devonian vertebrate on Ellesmere Island, *Holoptychius bergmanni*, which was named in honour of a past PCSP director, the late Marty Bergmann. Like *Tiktaalik*, this large, predatory fish thrived in ancient stream systems. Ongoing research is focused on the evolution of older Paleozoic vertebrates and arthropods (creatures with skeletons on the outside of their bodies), which are poorly understood because of a lack of fossil discoveries. Shubin and Daeschler's team aims to locate more of these fossils to fill knowledge gaps in the history of life on Earth, including the early evolution of heads, necks, paired fins and jaws.

Several students and northern residents have been part of Shubin and Daeschler's field teams over the years. The team has provided schools in Resolute and Grise Fiord with replicas of the fossils they have discovered, and they have shared their research with students and the general public in Canada's North, the United States and abroad. Using footage filmed during recent field studies, a scientific documentary series was also developed based on Shubin's book, "*Your Inner Fish*," which explores evolutionary processes that led to modern-day human anatomy, including links to the team's discoveries on Ellesmere Island.



Paleontologists carefully excavate at the discovery site for multiple specimens of the transitional creature *Tiktaalik roseae* on Ellesmere Island.

"Working in the Canadian Arctic has given us a rare glimpse of fundamental events in the history of life."

– Ted Daeschler

Population biology of birds and small mammals on Bylot Island, Nunavut

Gilles Gauthier (Université Laval)

Featured story location on map: 9

Understanding the complex interconnections within an ecosystem and their changes over time involves examining different levels of an ecosystem's food chain, as well as the non-living parts of an ecosystem that influence plants and animals, such as soil and climate. Gilles Gauthier is leading a long-term study to examine species interactions and the potential impacts of warmer climate conditions on birds and small mammals, in addition to monitoring ongoing changes to the terrestrial ecosystem of Bylot Island, Nunavut. This project, which takes place in Sirmilik National Park and involves many students, has two main themes.

The first theme focuses on the impacts of environmental changes and wildlife management practices on animal population dynamics (e.g. survival, reproduction and population growth rate). To examine these issues, the research team is conducting a long-term study of Greater Snow Geese, which breed on the island and are banded to allow the team to identify returning individuals. Gauthier's team is examining if "trophic mismatch," where plants and animals respond to climate change impacts at different rates, is influencing geese. Despite observed earlier spring snowmelt and related earlier peak growth of plant food sources, the team has found that geese are not changing their breeding timing to match timing for optimal food availability, which negatively affects the growth of young. The team is also determining the impact of wildlife management practices, such as the establishment of spring hunts, on Greater Snow Geese to improve demographic models and guide hunting regulations.

The second theme focuses on the tundra food web (interconnections within the food chain) and examines the effects of climate change on predator-prey interactions. This is accomplished by monitoring the breeding activity and population dynamics of predators such as weasels and raptors and their prey, lemmings. One component of this theme investigates the annual movements and wintering strategy of Snowy Owls by following birds fitted with satellite transmitters. Another component focuses on the nesting ecology of Rough-legged Hawks, who build nests on steep slopes that are prone to slope movements triggered by changes in permafrost. To better evaluate the role of these predators in the control of lemming population cycles, a



A student releases a female Snowy Owl at Deception Bay, Quebec, after fitting it with a satellite transmitter.

large pen was built to keep predators away from lemmings. Gauthier's team has found that predation may play a key role in explaining the enigmatic, cyclic fluctuations in lemming abundance every three or four years in the High Arctic. Change in the depth and mechanical properties of the snow has also been found to influence lemming population fluctuations.

Several residents of Pond Inlet have helped Gauthier's field teams during over 20 years of field work on Bylot Island, assisting with activities such as bird monitoring and banding. The results of this work will improve understanding of potential climate change impacts on the tundra food web and contribute to improving wildlife management practices for several animal populations in future.

"Predator-prey interactions were found to be the dominant interaction controlling small to medium-size animals in the Arctic. Therefore, changes to the predator assemblage due to climate warming could have a dramatic impact on the whole tundra food web."

– Gilles Gauthier

Did you know?

Each fall, Greater Snow Geese travel about 3,900 km from their Canadian Arctic breeding grounds to their wintering sites along the eastern seaboard of the United States.

Cretaceous High Arctic paleoenvironmental and paleoclimate change

Claudia Schröder-Adams (Carleton University)

Featured story location on map: 10

Knowledge of paleoenvironmental (past environmental) conditions can be used to place current conditions into the context of Earth's history and assess potential environmental responses to future conditions. Information on paleoclimate (past climate) and past ocean environments during the Cretaceous Period (145 million to 66 million years ago) is limited from high latitudes, creating a gap in understanding this important period in the Canadian Arctic's paleoenvironmental history. Claudia Schröder-Adams is studying the ancient High Arctic environment through geological studies of a former basin of the Cretaceous Polar Sea, whose ancient sediments contain proxy (indirect) records of climate, marine life, ocean chemistry, sediment deposition and sea level changes. Her research team includes graduate student Alex Quesnel (Carleton University) and Jens Herrle (Goethe University, Frankfurt, Germany).

During the Cretaceous Period, Earth had substantial volcanic activity and related high levels of atmospheric greenhouse gases, which caused warmer average temperatures and higher sea levels than at present. The rock layers and marine fossils from the Sverdrup Basin, which underlies much of the northern Canadian Arctic Archipelago, are allowing Schröder-Adams and her research team to reconstruct ancient environmental conditions in the Sverdrup Basin during the Cretaceous Period. The team is integrating fossil and

geochemical analyses of rock samples to develop biological and chemical records and examine processes that influenced ancient climate. In 2014, they examined rock outcrops (exposures of rock layers above the surface) on Axel Heiberg and Ellesmere islands. This area of the Sverdrup Basin represents an ancient, shallow, marine shelf environment.

The research team has found that lush vegetation existed in the study area during the Early Cretaceous Period, as evidenced by coal and petrified (fossilized) wood in rocks from this time. The presence of the calcium carbonate mineral ikaite in these rocks indicates intermittent, near-freezing conditions on the sea floor. Its disappearance from the geological record by the Late Cretaceous Period coincides with a warming Earth. Marine fossils show that marine shelf areas of the Sverdrup Basin were oxygen-rich at times, with thriving benthic (sea floor) life. The team also identified the positions of Cretaceous Oceanic Anoxic Events in the geological record for the first time in the Arctic. These events were times when the world's oceans had no oxygen below surface waters. During these events, the Polar Sea had abundant nutrients and warm surface temperatures that fostered high marine productivity and low benthic oxygen conditions. These complex marine chemical processes and related ancient marine communities are being examined further.

In 2014, Keenan Lindell, a resident of Iqaluit, joined the field team to film the field studies, and this footage is being transformed into a scientific documentary. Schröder-Adams plans to distribute the film to schools in the North and to schools in southern Canada through Carleton University's outreach programs.



Claudia Schröder-Adams's field team samples the Deer Bay Formation at Lost Hammer Diapir on Axel Heiberg Island.

"The Cretaceous Period is an enigmatic interval in Earth's history where geological processes caused the planet to warm. The Sverdrup Basin offers a window into a better understanding of the Polar Sea's response to a greenhouse Earth."

– Claudia Schröder-Adams

Causes and consequences of Arctic environmental change: A multiscale approach

Trevor Lantz (University of Victoria) and **Robert Fraser** (Natural Resources Canada)

Featured story location on map: 11

Vegetation change caused by a warming climate and human disturbance has a significant impact on Arctic ecosystem processes. In collaboration with researchers at NRCan and the Northwest Territories Geological Survey, Trevor Lantz and his students are examining the causes and effects of ongoing environmental changes in the Mackenzie Delta region of the Northwest Territories, focusing specifically on the interaction between vegetation, soils and permafrost.

To examine landscape change across a 15,000 km² study area that covers the treeline zone on the Tuktoyaktuk Coastal Plain, Lantz's team is integrating fine-scale field studies, high-resolution air photo assessments and broad-scale satellite imagery to detect and map changes in vegetation communities. They are using paired air photos, taken at the same locations in 1980 and in 2013 and 2014, to compare vegetation cover and composition and satellite imagery to detect and interpret vegetation cover changes using the Normalized Difference Vegetation Index (NDVI). Field studies to verify and detail findings from the analysis of air photo and satellite imagery involve comprehensive assessments of vegetation cover and soil conditions at plots across the region.

Lantz's team has found that vegetation is changing across the study region, with rapid shrub expansion into areas previously dominated by lichen cover, most notably in the coastal areas of the Tuktoyaktuk Peninsula. These results are outlined in a 2014 article published in *Ecosystems*. The research team is currently focusing on small-scale examination of lichen, dwarf shrubs and spruce to further assess ongoing vegetation changes. Because the observed changes may influence snow cover, soil temperatures and caribou habitat, the results of this work contribute to understanding current and potential ecological changes in the Mackenzie Delta region and informing decision-making about infrastructure.

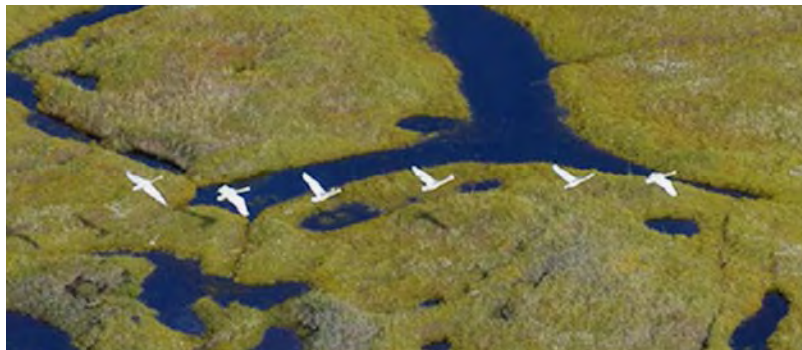
"We seek to combine process-oriented field studies, fine-scale models and broad-scale mapping into realistic predictions of landscape change that will make a direct contribution to decision-making associated with infrastructure."

– Trevor Lantz



Cameras are mounted on a helicopter to take high-resolution air photos in the Mackenzie Delta region.

Lantz's team has received valuable field assistance from local community members throughout the project. The team has also worked with the Northwest Territories Cumulative Impacts Monitoring Program to develop a vegetation and permafrost monitoring protocol that can be implemented by a range of participants with basic training. Since 2010, they have worked with northern residents, community organizations, students and government scientists to establish more than 80 sites in the Mackenzie Delta area to develop baseline knowledge and monitor changes in vegetation, snow and permafrost. By creating local capacity to monitor change, Lantz's team has created a long-term community benefit of its research.



Birds fly over ponds in the Tuktoyaktuk Coastlands, Northwest Territories.

Network on Climate and Aerosols: Addressing Key Uncertainties in Remote Canadian Environments (NETCARE)

Jon Abbatt (University of Toronto)

Featured story location on map: 12

Aerosols are tiny solid or liquid particles in the air that play an important role in climate processes. Some aerosols reflect the Sun's energy and cool the atmosphere; others absorb energy and heat the air; and all aerosols help to form clouds. Jon Abbatt is leading a study to examine aerosols in the Canadian Arctic and their influences on climate. The NETCARE (Network on Climate and Aerosols: Addressing Key Uncertainties in Remote Canadian Environments) project is part of the Canadian Climate and Atmospheric Research program of the Natural Sciences and Engineering Research Council of Canada. It involves Canadian and international scientists from universities and government agencies and more than 20 graduate students and post-doctoral fellows.

As one part of the project, the research team is examining aerosols in the Lancaster Sound area near Resolute, Nunavut. They are using air measurements taken from aircraft; air and ocean water measurements taken from the Canadian Coast Guard Ship (CCGS) *Amundsen*; and ground-based

air measurements taken at the Resolute weather station. In 2014, Richard Leaitch (Environment Canada) and Andreas Herber (Alfred Wegener Institute) led the project's aircraft work. Maurice Levasseur (Université Laval) and Jennifer Murphy (University of Toronto) led the ship studies. In addition to aerosols, trace gases (gases that comprise less than 1 percent of the atmosphere) are being studied because some, including dimethyl sulphide (DMS), play an important role in aerosol production. Knowledge of how DMS forms in the ocean and transfers to the atmosphere is limited, especially in the Arctic Ocean. Aircraft and ship-based measurements of aerosols and trace gases have been done concurrently to allow researchers to examine data from the upper ocean through the lower atmosphere at the same time.

This study is focusing on the marginal ice zone where open ocean processes impact sea ice properties. The goal is to determine if these areas are biologically productive, which would make them potentially important sources of trace gas. Water surface conditions such as open water, sea ice cover and polynya are being investigated as possible influences on aerosol formation. Data from clouds in the study area is also being analyzed to understand their relationship to aerosol abundance. Additionally, air measurements from the emission plume of the CCGS *Amundsen* during 2014 field work are being studied to examine how aerosols from ship emissions change over time and could impact northern climate processes.

Further NETCARE research will use aircraft measurements and ground-based studies at Alert, Nunavut, to examine the roles of atmospheric black carbon (soot) particles and ice clouds on the Arctic climate system. The results of this study will improve understanding of the potential impacts of aerosols from natural emissions and human activity on Arctic climate processes and will increase the accuracy of climate models.



The Polar 6 aircraft flies by the CCGS *Amundsen* in Lancaster Sound, Nunavut, during field work in support of the NETCARE project.

“Understanding the relationships between natural emissions from the ocean and transported pollution is essential to better understand Arctic climate in a warming world.”

– Jon Abbatt

Cumberland Sound beluga survey

Steve Ferguson (Fisheries and Oceans Canada)

Featured story location on map: 13

Monitoring wildlife populations is important for understanding ecosystem health and informing wildlife management decisions. To examine the population status of Arctic marine mammals, Steve Ferguson and his research team conduct aerial surveys to count animals and observe behaviour. In 2014, their research focussed on belugas in Cumberland Sound on the eastern coast of Baffin Island, Nunavut.

The Cumberland Sound beluga population size is low compared to historic levels. Consequently, it has been designated by the Committee on the Status of Endangered Wildlife in Canada as a “threatened” population. However, a dependable population size estimate is not currently available. This beluga population was surveyed in 1990, 1999 and 2009 but the results of the 2009 survey were unreliable because of issues with data collection. The work of Ferguson’s team will provide an updated population estimate, contribute to long-term monitoring of population size trends, and inform decisions regarding wildlife management and harvest levels for subsistence hunting by local residents.

In August 2014, the field team completed multiple visual surveys in the northern and western parts of Cumberland Sound and photographic surveys in Clearwater Fiord, which is located at the northern end of Cumberland Sound and is home to the majority of the beluga population at this time of year. The study areas included locations that were identified by Pangnirtung residents as places where belugas are observed regularly (e.g. Clearwater Fiord) and occasionally (e.g. western Cumberland Sound).

The visual surveys involved four observers, including one student from Nunavut Arctic College, flying over study areas along straight lines called transects to count each whale seen and record details about each pod. For photographic surveys, a camera operator controlled two cameras attached to the underside of an aircraft and took overlapping images as the aircraft flew at a set altitude along transects. The images will be used to identify groups and count animals, as well as to determine water quality, which may influence the depth at which whales can be seen. To overcome challenges of past surveys and improve precision of population estimates, the field team spaced transects more closely than in previous studies.



Belugas at Cunningham Inlet, Nunavut

The research team will account for whales that are swimming too deeply to be seen during surveys by using information from previous telemetry research. In that work, satellite tags were attached to Cumberland Sound belugas. When each whale surfaced, data was transmitted to satellites for researchers to track how much time the whales spend diving.

Ferguson’s team plans to publish the results, provide them to the community of Pangnirtung and use them to give scientific advice to the Nunavut Wildlife Management Board. Ideally, future Cumberland Sound beluga surveys will be repeated every five years, though smaller surveys may take place over areas of particular interest more frequently.

“Past survey results have not provided a clear trend that would allow us to say if this beluga population is stable. That was the main incentive for this survey: to provide more abundance estimates that could assess whether the population might be growing as a result of management initiatives.”

– Steve Ferguson

Did you know?

Belugas are in the scientific order *Cetacea*. Other cetaceans include dolphins, narwhal and other types of whales.

Mackenzie Valley active layer and permafrost thermal monitoring

Sharon Smith (Natural Resources Canada)

Featured story location on map: 14

The thickness of the active layer (the top layer of permafrost soils that thaws during summer) and the temperatures of permafrost are important indicators of environmental change in northern environments. The GSC at NRCan maintains more than 100 permafrost monitoring sites in northern Canada, with several maintained in collaboration with the University of Ottawa and community partners. Some of the sites have been operating for 30 years or more. Because permafrost influences ecosystems, hydrological systems and landscape stability, it is important to characterize the state and evolution of permafrost and assess the influences of climate change and land disturbances on this important landscape feature.

As a part of this project, Sharon Smith and her colleagues focus their research on an area along the Mackenzie River, where the monitoring network has more than 60 study sites. The Mackenzie Corridor is a key transportation corridor and has a broad range of vegetation cover and permafrost conditions, making it a valuable region to study for detecting permafrost changes and informing decision-making regarding resource and infrastructure development. Smith's research team continuously records permafrost temperature at each monitoring site using a thermistor cable installed in a borehole 10 to 20 m deep. The active layer thickness is measured by using thaw tubes. Some sites also record snow depth and air and ground surface temperatures. The team uses this data to assess permafrost temperatures at various depths, compare results across the network and examine links between climate conditions and permafrost responses.

Results from this research indicate that permafrost temperatures in the Mackenzie Corridor have increased during the past 20 to 30 years, with a reduced rate of increase during the past few years, coinciding with air temperature trends. These temperature increases have been most pronounced at tundra sites rather than forest sites, where vegetation cover provides some insulation to the ground from air temperature fluctuations. Smith's team has also investigated the impacts of landscape disturbance in areas where vegetation has been removed because of fire or development activities. Such disturbances were found to have a greater impact on permafrost temperatures in the short-term than climate fluctuations, though cleared land causes a stronger response of permafrost to changing climate conditions in the long-term.

Smith's research team contributed data for a national "snapshot" of the thermal state of Canadian permafrost for the most recent International Polar Year (IPY 2007–2008), which became part of a global IPY data set and map. Smith's research team has widely published the study's findings, including a paper that details one of the first assessments of permafrost-climate links at a continental scale. The research team also provides summary reports to local community groups each year to communicate their ongoing research findings.

"Continued operation of the monitoring network will provide essential information to understand how permafrost is changing and to reduce uncertainty in the prediction of future conditions."

– Sharon Smith



Sharon Smith changes a data logger at a permafrost monitoring site south of Fort Simpson, Northwest Territories.

Did you know?

The continuous permafrost zone covers areas that are underlain by permafrost throughout the soil or bedrock while the more southern discontinuous zone has intermittent pockets of permafrost in the ground. In Canada, continuous zone permafrost can be as cold as -15°C , while discontinuous zone permafrost has temperatures that can reach nearly 0°C .

National parks monitoring and operations programs

Canada's North is home to 11 national parks and park reserves, which protect large tracts of wilderness that represent different natural regions for the benefit of all Canadians. Each year, the PCSP provides logistical support for park programs related to monitoring ecological integrity; maintaining archaeological and historical sites to protect the cultural heritage of parks; and conducting backcountry patrols and infrastructure maintenance for visitor safety. In 2014, the PCSP supported scientific and operational work being done by eight national parks. The following stories detail some of these field activities.

National parks in Yukon

Kluane National Park and Reserve: Located in southwestern Yukon, Kluane National Park and Reserve has stunning mountainous terrain, large river valleys, vast ice fields and Canada's highest peak, Mount Logan. In the late 1990s to early 2000s, an outbreak of the spruce bark beetle affected 49,000 hectares of white spruce forest and caused an unprecedented number of tree deaths in the park. Parks staff is examining the potential for forest recovery and is assessing forest resilience to disturbance as part of their annual operations and monitoring work. Since 2009, local volunteers have helped establish a network of 50 monitoring sites in the park. The sites are visited regularly to measure the density of white spruce regrowth and factors that could affect the success of tree regeneration, such as permafrost and the density of live and dead mature trees.

In 2014, the PCSP provided logistical support to a field team that included Parks Canada staff, a high school student from Kluane First Nation and a volunteer student chef. The high school student was on a *Students on Ice* internship with Parks Canada and the chef was from the park's *Cook in the Park* program. The team rafted along the Alsek River to establish four new monitoring plots in the area of the park where the spruce bark beetle was first detected in 1994 and to measure 10 of the original plots. The results of this ongoing work will help Parks Canada assess the ecological integrity of the park's forests and their resilience to future insect disturbances.



Parks Canada staff measure downed deadwood to monitor the impacts of spruce bark beetles in Kluane National Park and Reserve.

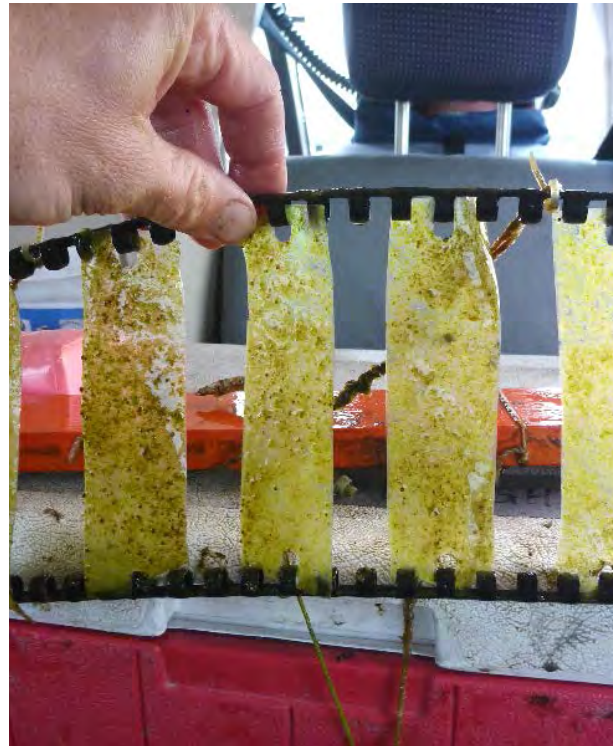
Vuntut National Park: With extensive lakes and wetlands, striking river valleys, rolling tundra and rocky peaks, Vuntut National Park covers a broad subarctic area of northwestern Yukon. The park contains a portion of Old Crow Flats (OCF), which has 2,700 shallow lakes and holds great cultural importance for the Vuntut Gwitchin First Nation. Recent observations in OCF indicate an increasingly dynamic landscape response to climate change, as seen through changes to water levels, surface area and biological communities in lakes and ponds. These highly productive ecosystems provide crucial habitat for abundant wildlife that local residents depend on for subsistence harvesting.

Emerging from a successful IPY 2007–2008 project, an ongoing monitoring program has been developed for OCF, in partnership with Parks Canada, the Vuntut Gwitchin Government, the North Yukon Renewable Resources Council and university researchers. Since 2012, Parks Canada has led field work to monitor the hydrological, limnological and ecological conditions of 14 OCF lakes and assess changes over time.

In 2014, the PCSP provided logistical support for field work in support of this program. The field work involved collecting water samples, measuring lake depth and water characteristics, and collecting samples of periphyton (a combination of algae, microbes, cyanobacteria and other organic matter found on underwater surfaces). The program's results are providing important insight for informing land management decisions and climate change adaptation strategies. Local involvement is integral to this program. Several Old Crow residents are involved with reviewing project design and implementation, helping with field work, and analyzing, interpreting, and presenting results to the community and project partners. The program's results contribute to Parks Canada's *State of the Park Report* series for Vuntut National Park, which includes local Traditional Knowledge and monitoring data.



A Parks Canada employee deploys a periphyton sampler in a monitored Old Crow Flats lake in Vuntut National Park.



A periphyton sampler is collected from a monitored Old Crow Flats lake.

National parks in the Northwest Territories

Aulavik National Park: Situated on northern Banks Island, Aulavik National Park has rolling tundra, picturesque river valleys, badlands areas, dynamic coastlines and many identified archaeological sites. In 2014, the PCSP gave logistical support for field work that contributed to four components of an ongoing ecological integrity monitoring program in the park. This work is providing Parks Canada with improved understanding of environmental changes in tundra and freshwater ecosystems over time.

In 2014, Parks Canada staff counted lemming winter nests at 17 study plots as part of a study that began in 1999 to examine lemming population cycles. They also examined population size and composition of benthic macroinvertebrates in two creeks. These creatures have no spine and live at the bottom of the streams. Water samples were also collected to assess water conditions and quality. Additionally, permafrost conditions were examined by measuring the active layer depth at two study sites. These four projects form the majority of ground-based monitoring that Parks Canada undertakes in Aulavik National Park.



A Parks Canada employee uses a probe to measure active layer thickness in Aulavik National Park.



Sedimentary rock layers along Hornaday River in Tuktut Nogait National Park

Tuktut Nogait National Park: Located off the southern coast of Amundsen Gulf, Tuktut Nogait National Park has sculpted river valleys, spectacular canyons, rolling tundra, several waterfalls and numerous archaeological sites. The Hornaday River flows through the park to Darnley Bay and provides habitat for many aquatic creatures, including a valued Arctic char population. The local community of Paulatuk relies on this fish population for subsistence harvesting.

As part of the park's baseline environmental monitoring program, Parks Canada oversees the Hornaday River Monitoring Program that began in 1998. This program is providing long-term information on annual streamflow changes and water quality, which are important for examining the river's dynamic freshwater ecosystems and how they are affected by environmental changes and human activity.

In 2014, the PCSP provided logistical support for Parks Canada and Water Survey of Canada employees to visit a river gauge site on the Hornaday River to maintain the gauges, collect water samples and measure river discharge. This data will be compared with a long-term data set from a gauge on the Anderson River, located west of the park, to better understand regional streamflow and water quality variability. The Hornaday River discharge data is part of fish, water quality and benthic macroinvertebrate monitoring studies that Parks Canada conducts in upstream locations. The results of the Hornaday River Monitoring Program are important for assessing ecosystem health over time and sustainably managing the river's Arctic char population, as specified in the Tuktut Nogait Management Plan.

National parks in Nunavut

Auyuittuq National Park: Encompassing the land and coastal areas on the Cumberland Peninsula of eastern Baffin Island, Auyuittuq National Park contains striking mountainous terrain, the beautiful Penny Ice Cap and many deep fiords. It is the most-visited national park in the Arctic without road access. Each year, Parks Canada employees conduct operations work in the park to support visitor safety, infrastructure maintenance, ecological monitoring, education and outreach. In 2014, the PCSP provided logistical support for work to maintain emergency shelters and radio repeater sites, which provide a radio communications system for the park.

Quttinirpaaq National Park: Located on Ellesmere Island, Quttinirpaaq National Park is Canada's northernmost national park and about one-third of it is covered in 120,000-year-old ice caps and glaciers. Other landscape features include ice shelves and the Lake Hazen area, a unique Arctic oasis that is rich in flora and fauna despite the high latitude. In 2014, the PCSP provided logistical support for Parks Canada's operations, which included conducting ecological monitoring studies and conservation patrols, enforcing the *Canada National Parks Act* and providing visitor services.

Ecological monitoring included monitoring flowering times of mountain aven and purple saxifrage as part of the International Tundra Experiment and monitoring permafrost and active layer thickness as part of the Circumpolar Active Layer Monitoring (CALM) program. Parks Canada staff also took water quality and river discharge measurements in the park. Additionally, ice thickness measurements and Arctic



Thor Peak in Auyuittuq National Park

char specimens were collected at Lake Hazen as part of joint studies with Environment Canada.

The park also participated in insect collection as part of the Canadian National Parks Malaise Program (University of Guelph). Three resource conservation patrols were conducted that focused on recording wildlife observations and identifying potential new locations of interest for visitors; searching for archeological sites and monitoring existing ones; and identifying hazards to visitors caused by landscape changes such as glacier movements and changes in stream levels.

Ukkusiksalik National Park: Ukkusiksalik National Park encompasses lands surrounding Wager Bay — a major inlet of western Hudson Bay. The park protects 20,885 km² of glacially sculpted tundra, prominent cliffs, broad rivers, striking coastal areas and more than 500 identified archaeological sites.

In 2014, the PCSP provided logistical support for operations and monitoring programs in the park that supported visitor safety, staff training, ecological research and monitoring, and infrastructure maintenance. These activities included basic repairs to Sila Lodge (a naturalist lodge on the northern shore of Wager Bay); examination of fuel caches; and maintenance of five repeater sites that form the park's radio communications system. Ukkusiksalik National Park is also responsible for maintaining the historic Hudson Bay Company Post buildings on Ford Lake, which were inspected in 2014. Parks Canada staff also established a new permafrost monitoring grid near Sila Lodge as part of the CALM network.



Parks Canada employees use an auger while measuring ice thickness on Lake Hazen in Quttinirpaaq National Park.

List of science projects in 2014

Assessing the impact of Lesser Snow Geese and Cackling Geese competition on breeding Atlantic Brant

Primary investigator: Kenneth Abraham
(Trent University)

Location: East Bay Mainland Goose Camp
(Southampton Island), Nunavut

Karrak Lake assessment of continental efforts at population reduction of Light Geese

Primary investigator: Ray Alisauskas
(Environment Canada)

Locations: Karrak Lake and Perry River,
Nunavut

Breeding ecology of High Arctic marine birds, Prince Leopold Island

Primary investigator: Jason Akearok
(Environment Canada)

Location: Prince Leopold Island, Nunavut

Survival in Arctic geese (Perry River, Queen Maud Gulf Bird Sanctuary)

Primary investigator: Ray Alisauskas
(Environment Canada)

Locations: Atkinson Point River and Perry
River, Nunavut

Hornaday River Monitoring Program 2014

Primary investigator: Herbert Allen
(Parks Canada)

Location: Hornaday River, Northwest
Territories

Gastro-intestinal bioaccessibility of contaminants in traditional food

Primary investigator: Marc Amyot
(Université de Montréal)

Location: Resolute (Cornwallis Island),
Nunavut

Peary caribou landscape genetics

Primary investigator: Morgan Anderson
(Department of Environment, Government
of Nunavut)

Locations: Eureka, Vesle Fiord, Bjome
Peninsula, Raanes Peninsula, and
Sydkap Ice Cap (Ellesmere Island), Schei
Peninsula (Axel Heiberg Island), Cape
Bounty (Melville Island), Graham Island,
and Polar Bear Pass and Twilight Creek
(Bathurst Island), Nunavut

Southern Ellesmere Peary caribou and muskox aerial survey

Primary investigator: Morgan Anderson
(Department of Environment, Government
of Nunavut)

Locations: Grise Fiord and various
locations on southern Ellesmere Island,
Nunavut

An Arctic wolf at Slide
Fiord, Ellesmere Island



2014 Ice Patch Monitoring Project

Primary investigator: Tom Andrews
(Prince of Wales Northern Heritage Centre)
Location: Mile 222 area, Northwest Territories

Genetic mark-recapture population assessment of polar bears in Kane Basin, Nunavut

Primary investigator: Stephen Atkinson
(Department of Environment, Government of Nunavut)
Locations: Grise Fiord and Alexandra Fiord (Ellesmere Island), Nunavut

Boreal forests on permafrost: Functional trait and whole-plant responses to climate warming and permafrost thaw

Primary investigator: Jennifer Baltzer
(Wilfrid Laurier University)
Location: Trail Valley, Northwest Territories

Fitness drivers in long-distance migrants: The interacting roles of physiology, social biology, ecological and physical environments

Primary investigator: Stuart Bearhop
(University of Exeter, United Kingdom)
Locations: Eureka (Ellesmere Island) and Schei Peninsula (Axel Heiberg Island), Nunavut

Geo-mapping for Energy and Minerals Phase 2 (GEM-2) - Thelon-Chantrey Project 2014

Primary investigator: Rob Berman
(Natural Resources Canada)
Location: Goose Lake, Nunavut

Ecology of Arctic and red fox on Bylot Island

Primary investigator: Dominique Berteaux
(Université du Québec à Rimouski)
Locations: Bylot Island Field Station and various locations on Bylot Island, Nunavut

Ecology of insectivorous birds on Bylot Island

Primary investigator: Joël Bêty
(Université du Québec à Rimouski)
Locations: Bylot Island Field Station and various locations on Bylot Island, Nunavut

Impacts of recent climate warming on Canada's northern aquatic ecosystems

Primary investigator: Jules Blais
(University of Ottawa)
Location: Yellowknife area, Northwest Territories

Aerosol Chemical Composition in the Arctic (ACCA) - in situ measurements in Tuktoyaktuk, Northwest Territories

Primary investigator: Stephan Borrmann
(Max Planck Institute for Chemistry, Germany)
Location: Tuktoyaktuk, Northwest Territories

State and evolution of Canada's glaciers/ECV mass balance - Queen Elizabeth Islands, Nunavut and Northwest Territories

Primary investigator: David Burgess
(Natural Resources Canada)
Locations: Agassiz Ice Cap and Grise Fiord (Ellesmere Island), Meighen Ice Cap (Meighen Island), Devon Ice Cap (Devon Island), Nunavut, and Melville Ice Cap (Melville Island), Northwest Territories

Permafrost and climate change, western Arctic Canada

Primary investigator: Christopher Burn
(Carleton University)
Locations: Garry Island and Illisarvik, Northwest Territories

A latitudinal investigation of ecosystem sensitivity to methylmercury bioaccumulation in fresh waters of the eastern Arctic

Primary investigator: John Chételat
(Environment Canada)
Location: Resolute (Cornwallis Island), Nunavut

Monitoring of glaciers and ice shelves across the northern Queen Elizabeth Islands

Primary investigator: Luke Copland
(University of Ottawa)
Locations: Expedition Fiord, Axel Heiberg Island, and Purple Valley, Ellesmere Island, Nunavut



A polar bear near Nettiiling Lake,
Baffin Island



Arctic poppy

Geo-mapping for Energy and Minerals Phase 2 (GEM-2) - Hudson Ungava Minerals - 2014

Primary investigator: David Corrigan
(Natural Resources Canada)

Locations: George River area, Kuujuaq and Schefferville, Quebec

Evaluating the impacts of mega-scale permafrost disturbances on northern streams

Primary investigator: Joseph Culp
(University of New Brunswick)

Location: Fort McPherson, Northwest Territories

Sampling of Quaternary glacial sediments exposed in Tuktoyaktuk Coastlands and Amundsen Gulf area as a basis for comparison with marine sequences on Beaufort Shelf and Slope

Primary investigator: Scott Dallimore
(Natural Resources Canada)

Locations: Herschel Island, Yukon, and Richards Island and Banks Island, Northwest Territories

State and evolution of Canada's glaciers/ECV mass balance - northern Cordillera, Northwest Territories

Primary investigator: Michael Demuth
(Natural Resources Canada)

Location: Brintnell-Bologna Icefield, Northwest Territories

Movement patterns and population structure of polar bears in a changing climate

Primary investigator: Andrew Derocher
(University of Alberta)

Location: Polar Bear Cabin (Banks Island), Northwest Territories

Study of the acceleration of permafrost thawing by climate-induced changes in snow physical properties

Primary investigator: Florent Domine
(Université Laval)

Location: Bylot Island Field Station (Bylot Island), Nunavut

Airborne geophysical investigations of conditions at the bed of fast-flowing outlet glaciers of large Canadian Arctic ice caps

Primary investigator: Julian Dowdeswell
(Scott Polar Research Institute, University of Cambridge, United Kingdom)

Location: Eureka (Ellesmere Island), Nunavut

Climate warming in the Canadian High Arctic: Effects on lakes

Primary investigator: Paul Drevnick
(Institut national de la recherche scientifique, Centre Eau Terre Environnement)

Location: Resolute (Cornwallis Island), Nunavut



Driftwood windbreaks on Herschel Island,
Yukon

M'Clintock Channel polar bear inventory

Primary investigator: Markus Dyck
(Department of Environment, Government of Nunavut)

Locations: M'Clintock Channel area, Cambridge Bay (Victoria Island), Cape Sydney (King William Island) and Fort Ross (Somerset Island), Nunavut

State and evolution of Canada's Glaciers - Mass Balance, Baffin Island, Nunavut

Primary investigator: Mark Ednie
(Natural Resources Canada)

Location: Penny Ice Cap (Baffin Island), Nunavut

BBC "Arctic Wolf" series at Eureka

Primary investigator: Patrick Evans
(British Broadcasting Corporation)

Location: Eureka area (Ellesmere Island), Nunavut

Shale basin evolution in the central Northwest Territories mainland

Primary investigator: Kathryn Fiess
(Northwest Territories Geological Survey)
Locations: Bell Creek, Carcajou Ridge, Hume River, Imperial River, Mountain River and Summit Creek, Northwest Territories

Cumberland Sound beluga survey

Primary investigator: Steve Ferguson
(Fisheries and Oceans Canada)
Locations: Areas in Cumberland Sound near Pangnirtung (Baffin Island), Nunavut

Jones Sound narwhal research

Primary investigator: Steve Ferguson
(Fisheries and Oceans Canada)
Locations: Areas in Jones Sound near Grise Fiord (Ellesmere Island), Nunavut

Tracking the movement of Arctic cod, sculpin, Greenland sharks, and ringed seals in Lancaster Sound

Primary investigator: Aaron Fisk
(University of Windsor)

Locations: Areas in Maxwell Bay (Devon Island) and Resolute Bay (Cornwallis Island), Nunavut

Glacier mass balance variability in a small subarctic mountain range, southwest Yukon Territory

Primary investigator: Gwenn Flowers
(Simon Fraser University)

Locations: Canada Creek, Kaskawulsh Glacier and Kluane Glacier, Yukon

CryopVEx-2014

Primary investigator: René Forsberg
(National Space Institute, Technical University of Denmark)

Location: Eureka (Ellesmere Island), Nunavut

REP-ARC2: Arctic periglacial ecosystem responses to climate change

Primary investigator: Daniel Fortier
(Université de Montréal)

Locations: Bylot Island Field Station and various locations on Bylot Island, Nunavut

Arctic cultural heritage at risk: Climate change impacts on the archaeological record in the western Canadian Arctic

Primary investigator: Max Friesen
(University of Toronto)

Locations: Kuukpak (Richards Island), Liverpool Bay and Tuktoyaktuk Peninsula, Northwest Territories

Biology of tundra bird and small mammal populations: Demographics, trophic interactions, and climate change

Primary investigator: Gilles Gauthier
(Université Laval, Centre for Northern Studies)

Locations: Bylot Island Field Station and various locations on Bylot Island, Nunavut

Population studies of Common and King Eider Ducks breeding at East Bay, Southampton Island, Nunavut, 2014

Primary investigator: Grant Gilchrist
(Environment Canada)

Location: East Bay (Southampton Island), Nunavut

Geo-mapping for Energy and Minerals Phase 2 (GEM-2) - Triassic Source Rock Assessment - 2014

Primary investigator: Stephen Grasby
(Natural Resources Canada)

Locations: Borup Fiord and Alexandra Fiord (Ellesmere Island), Nunavut

CASIMBO: Canadian Arctic Sea Ice Mass Balance Observatory

Primary investigator: Christian Haas
(York University)

Locations: Sea ice areas near Alert (Ellesmere Island) and Resolute (Cornwallis Island), Nunavut, and Sachs Harbour (Banks Island), Northwest Territories

The end of an era: Evaluating paleoenvironmental change in the latest Mesoproterozoic (ca. 1.1 billion years old) Bylot Supergroup, Baffin Island

Primary investigator: Galen Halverson
(McGill University)

Locations: Tremblay Sound, Adams Sound, Alpha River and Angmaat Mountain (Baffin Island), Nunavut

Abundance and distribution of walrus in Hudson Strait and Hudson Bay

Primary investigator: Michael O. Hammill
(Fisheries and Oceans Canada)

Locations: Areas in Hudson Strait and Hudson Bay near Kangirsuk, Kangiqsujaq, Ivujivik, Salluit and Puvirnituq, Quebec and Sanikiluaq (Belcher Islands), Cape Dorset (Baffin Island), Coral Harbour (Southampton Island), Repulse Bay, Arviat and Iqaluit, (Baffin Island), Nunavut

Fishery independent sampling of Cambridge Bay Arctic char (*Salvelinus alpinus*) stocks and Halovik River weir enumeration

Primary investigator: Les Harris
(Fisheries and Oceans Canada)

Locations: Halovik River, Jayko River, Ekalluk River and Surrey River (Victoria Island), Nunavut

Species and ecosystem constraints on increasing vegetation cover in the High Arctic

Primary investigator: Greg Henry
(University of British Columbia)

Locations: Sverdrup Pass, Alexandra Fiord, Hot Weather Creek, Eastwind Lake, Eureka and Princess Marie Bay (Ellesmere Island), Nunavut

Archaeological investigations of past hunting landscapes on Banks Island, Northwest Territories

Primary investigator: Lisa Hodgetts
(Western University)

Locations: Sachs Harbour and Fish Lake (Banks Island), Northwest Territories

Population assessment of Dolly Varden

Primary investigator: Kimberly Howland
(Fisheries and Oceans Canada)

Locations: Babbage River, Big Fish River and Rat River, Northwest Territories



A student examines the stability of a slope on Bylot Island to determine the vulnerability of a Rough-legged Hawk nest to mass movements.

Improved retrievals of snow depth on sea ice for numerical sea ice prediction applications

Primary investigator: Stephen Howell
(Environment Canada)

Locations: Sea ice areas near Eureka (Ellesmere Island), Nunavut

BBC's "The Hunt" Ellesmere Island Shoot

Primary investigator: Jonnie Hughes
(Silverback Films and Hunter Films)

Location: Eureka area (Ellesmere Island), Nunavut

Provenance of clastic sediments in the Sverdrup Basin, Canadian Arctic Islands

Primary investigator: Peter Hülse
(CASP, University of Cambridge, United Kingdom)

Locations: Mount James, Fosheim Peninsula, Blue Mountains, and Eureka (Ellesmere Island) and Expedition Fiord (Axel Heiberg Island), Nunavut



This bone point with part of its wooden handle and lashings still intact was found at an excavation site on Banks Island.

Assessing risks of wildlife diseases in the Canadian North

Primary investigator: Emily Jenkins
(University of Saskatchewan)

Locations: Karrak Lake and Perry River, Nunavut

Darnley Bay nearshore fish survey

Primary investigator: Jim Johnson
(Fisheries and Oceans Canada)

Locations: Bennett Point, Darnley Bay, Brown's Harbour and Paulatuk, Northwest Territories

Fishing Branch River chum salmon habitat assessments

Primary investigator: William Josie
(Natural Resources Department, Vuntut Gwitch'in Government)

Locations: Dawson and Eagle Plains, Yukon

Porcupine River Chinook salmon telemetry and genetic sample collection

Primary investigator: William Josie
(Natural Resources Department, Vuntut Gwitch'in Government)

Location: Old Crow, Yukon

Porcupine River chum salmon radio telemetry

Primary investigator: William Josie
(Natural Resources Department, Vuntut Gwitch'in Government)

Location: Dawson, Yukon

Integrated landscape and aquatic system processes and impacts due to changing permafrost

Primary investigator: Scott Lamoureux
(Queen's University)

Location: Cape Bounty (Melville Island), Nunavut

Causes and consequences of Arctic environmental change: A multiscale approach

Primary investigator: Trevor Lantz
(University of Victoria)

Locations: Husky Lakes, Jimmy Lake, Kugmallit Bay, Parsons Lake and Richards Island, Northwest Territories

Arctic pond gas emission contributions to the greenhouse effect: Geomorphological and microbial influences

Primary investigator: Isabelle Laurion
(Institut national de la recherche scientifique, Centre Eau Terre Environnement)

Location: Bylot Island Field Station (Bylot Island), Nunavut

Baffin Island goose banding

Primary investigator: Jim Leafloor
(Environment Canada)

Location: Southern Baffin Island, Nunavut

Southampton Island goose banding

Primary investigator: Jim Leafloor
(Environment Canada)

Location: Coral Harbour (Southampton Island), Nunavut

Airborne observations in support of NETCARE (Network on Climate and Aerosols: Addressing Key Uncertainties in Remote Canadian Environments)

Primary investigator: Richard Leitch
(Environment Canada)

Location: Resolute (Cornwallis Island), Nunavut



Small lakes and river channels on the Mackenzie Delta, Northwest Territories

ARCTIC IMPACT: Arctic Integrative Monitoring of Predators in the Arctic Tundra

Primary investigator: Nicolas Lecomte
(Université de Moncton)
Location: Igloodik Island, Nunavut

Greater Snow Goose population dynamics relating to habitat

Primary investigator: Josée Lefebvre
(Environment Canada)
Location: Bylot Island, Nunavut

Limnology and biogeochemistry of Arctic delta lakes

Primary investigator: Lance Lesack
(Simon Fraser University)
Location: Inuvik, Northwest Territories

Stress-mediated mechanisms linking individual state, climatic variation, and population health in Arctic-breeding birds

Primary investigator: Oliver Love
(University of Windsor)
Location: East Bay Island Camp
(Southampton Island), Nunavut

Contaminants in seabirds at Prince Leopold Island, Nunavut

Primary investigator: Mark Mallory
(Acadia University)
Location: Prince Leopold Island, Nunavut

Movements and survival of rare, High Arctic seabirds

Primary investigator: Mark Mallory
(Acadia University)
Location: Tern Island, Nunavut

Waves in sea ice and shoreline change: Yukon coast

Primary investigator: Gavin Manson
(Natural Resources Canada)
Location: Pauline Cove (Herschel Island), Yukon

Hydrological studies of Mackenzie Delta region

Primary investigator: Philip Marsh
(Environment Canada)
Location: Trail Valley Creek, Northwest Territories

Fishery resource management science investigation of sustainable harvest in Nettilling Lake — the largest single system commercial Arctic char quota in Nunavut

Primary investigator: Zoya Martin
(Fisheries and Oceans Canada)
Locations: Amadjuak Lake and Nettilling Lake (Baffin Island), Nunavut



Bylot Island Research Station, Nunavut

Hydrological and ecological monitoring in Old Crow Flats, Yukon, 2014

Primary investigator: Ian McDonald
(Parks Canada)

Location: Old Crow, Yukon

Baseline ecological studies on southern Victoria Island to support CHARS research and monitoring programs

Primary investigator: Donald McLennan
(Polar Knowledge Canada)

Locations: Hadley Bay, Collingwood Range, Surrey Lake and Byron Bay (Victoria Island), Nunavut

Hazardous sea ice in the Canadian Archipelago

Primary investigator: Humfrey Melling
(Fisheries and Oceans Canada)

Locations: Areas in Byam Martin Channel, based from Resolute (Cornwallis Island), Nunavut

Disappearing Ice Caps

Primary investigator: Gifford Miller
(Institute for Arctic and Alpine Research, University of Colorado Boulder, United States)

Locations: Allen Island, Allen's Cabin, and Cumberland Peninsula (Baffin Island), Nunavut

Climate change and the Arctic archaeological record: An archaeo-geophysical approach to assess site stability and predict future impact

Primary investigator: Brooke Milne
(University of Manitoba)

Location: Southern Baffin Island, Nunavut

A watershed-scale sampling protocol for accurate distribution and trend assessments of Bull Trout populations in the Northwest Territories

Primary investigator: Neil Mochnacz
(Fisheries and Oceans Canada)

Location: Prairie Creek, Northwest Territories

Understanding the distribution and ecological thresholds of chars in the Canadian Western Arctic

Primary investigator: Neil Mochnacz
(Fisheries and Oceans Canada)

Locations: Lake 34 and Lake 35 (Yukon North Slope), Yukon, and Grassy Lake, Rat River and Wolf Lake, Northwest Territories

Hydrodynamics of permafrost-glacier systems

Primary investigator: Brian Moorman
(University of Calgary)

Location: Eclipse Sound (Bylot Island), Nunavut

Investigating the role of ocean dynamics and meltwater input on the fate of Ellesmere Island ice shelves, ice tongues, and epishelf lakes

Primary investigator: Derek Mueller
(Carleton University)

Locations: Purple Valley, Milne Fiord and Milne Ice Shelf (Ellesmere Island), Nunavut

Investigating potential regional effects of climate warming on mercury and other contaminants in landlocked Arctic char (*Salvelinus alpinus*)

Primary investigator: Derek Muir
(Environment Canada)

Locations: Cape Bounty (Melville Island) and Resolute (Cornwallis Island), Nunavut

Ice Covered Ecosystem - CAMbridge Bay Process Studies (ICE-CAMPS)

Primary investigator: C.J. Mundy
(University of Manitoba)

Location: Dease Strait, Nunavut

Arctic predator-prey dynamics and overabundant snow goose grazing on demography and ecophysiology of Arctic-breeding shorebird populations

Primary investigator: Erica Nol
(Trent University)

Location: Coats Island, Nunavut

Slave Banting Group volcanogenic massive sulphide base metal evaluation

Primary investigator: Luke Ootes
(Northwest Territories Geological Survey)

Locations: Colomac and Victory Lake, Northwest Territories

Testing the antiquity of the East Arm basin, Great Slave Lake

Primary investigator: Luke Ootes
(Northwest Territories Geological Survey)

Locations: Taltheilei Narrows and Wilson Island, Great Slave Lake, Northwest Territories

Geo-mapping for Energy and Minerals Phase 2 (GEM-2) - South Rae - 2014

Primary investigator: Sally Pehrsson
(Natural Resources Canada)

Locations: Locations in the Selwyn Lake area, Northwest Territories

Geo-mapping for Energy and Minerals Phase 2 (GEM-2) - Montresor Belt Field Activity - 2014

Primary investigator: John Percival
(Natural Resources Canada)

Locations: Locations southwest of Montresor River, Nunavut

Long-term limnological and paleolimnological monitoring of Nettilling Lake, central Baffin Island, Nunavut, Canada

Primary investigator: Reinhard Pienitz
(Université Laval, Centre for Northern Studies)

Location: Nettilling Lake (Baffin Island), Nunavut

CASE 16 Alexandra Fiord

Primary investigator: Karsten Piepjohn
(Federal Institute for Geosciences and Natural Resources, Germany)

Locations: Stenkul Fiord, Flagler Bay and Alexandra Fiord (Ellesmere Island), Nunavut

Examining the impacts of climate and environmental change on aquatic and terrestrial ecosystems of the Mackenzie region, Northwest Territories

Primary investigator: Michael Pisaric
(Brock University)

Locations: Fort McPherson and Inuvik areas, Northwest Territories

McGill Arctic Research Station science program

Primary investigator: Wayne Pollard
(McGill University)

Location: Expedition Fiord (Axel Heiberg Island), Nunavut

The vulnerability and resiliency of High Arctic permafrost to climate change

Primary investigator: Wayne Pollard
(University of McGill)

Locations: Eureka (Ellesmere Island), Expedition Fiord and Whitsunday Bay (Axel Heiberg Island), Nunavut

Viscount Melville Sound polar bear sub-population survey

Primary investigator: Jodie Pongracz
(Environment and Natural Resources, Government of Northwest Territories)

Locations: Cape Providence and Nias Point (Melville Island), Mould Bay (Prince Patrick Island), Polar Bear Cabin (Banks Island) and Winniatt Bay (Victoria Island), Northwest Territories



An Arctic fox, fitted with a satellite transmitter collar, finds a Greater Snow Goose egg on Bylot Island, Nunavut.

Effects of changing freshwater ice regimes

Primary investigator: Terry Prowse
(Environment Canada)

Location: Greiner Lake (Victoria Island),
Nunavut

Geo-mapping for Energy and Minerals Phase 2 (GEM-2) - Darnley Bay-Brock Inlier - 2014

Primary investigator: Rob Rainbird
(Natural Resources Canada)

Location: Hope Bay, Nunavut

Geo-mapping for Energy and Minerals Phase 2 (GEM-2) - Elu Basin - 2014

Primary investigator: Rob Rainbird
(Natural Resources Canada)

Locations: Brock River and Hornaday River,
Northwest Territories



Researchers sample water through the ice of Teardrop Lake near Resolute, Nunavut.

Arctic Shorebird Monitoring Program (Arctic PRISM) - Queen Elizabeth Islands West

Primary investigator: Jennie Rausch
(Environment Canada)

Locations: Cape Bounty (Melville Island) and Polar Bear Pass (Bathurst Island), Nunavut, and Mould Bay (Prince Patrick Island), Northwest Territories

Aerial surveys of Pacific Common Eiders in the central Canadian Arctic

Primary investigator: Myra Robertson
(Environment Canada)

Location: Cambridge Bay (Victoria Island),
Nunavut

Flora of the Canadian Arctic

Primary investigator: Jeffery Saarela
(Canadian Museum of Nature)

Locations: Sandstone Falls, Kugluktuk and Bloody Falls, Nunavut

Observational constraints on glacier sliding and subglacial hydrology

Primary investigator: Christian Schoof
(University of British Columbia)

Location: Kaskawulsh Glacier, Yukon

Cretaceous High Arctic paleoenvironmental and paleoclimate change

Primary investigator:
Claudia Schröder-Adams
(Carleton University)

Locations: Glacier Fiord and Lost Hammer Diapir (Axel Heiberg Island) and southern areas of Slidre Fiord (Ellesmere Island), Nunavut

Dynamics and change of Devon Ice Cap, Nunavut

Primary investigator: Martin Sharp
(University of Alberta)

Locations: Belcher Glacier, Sverdrup Glacier and various locations on Devon Ice Cap, Devon Ice Cap (Devon Island), Nunavut

In search of early vertebrates and arthropods: The Cambrian-Silurian succession of northern Ellesmere Island

Primary investigator: Neil Shubin
(University of Chicago, United States)

Location: Judge Daly Promontory
(Ellesmere Island), Nunavut

Ecological integrity monitoring of tundra and freshwater ecosystems in Aulavik National Park

Primary investigator: Peter Sinkins
(Parks Canada)

Location: Green Cabin (Banks Island),
Northwest Territories

Population studies of shorebirds at East Bay Mainland and Coats Island, Nunavut

Primary investigators: Paul Smith and Jennie Rausch (Environment Canada)

Locations: Coats Island and East Bay Mainland (Southampton Island), Nunavut

Mackenzie Valley active layer and permafrost thermal monitoring

Primary investigator: Sharon Smith
(Natural Resources Canada)

Locations: Inuvik and Norman Wells,
Northwest Territories



Field gear is unloaded for geological field work at Glacier Fiord, Axel Heiberg Island.

Van Tat Gwitch'in Navigation Systems Project (Year four)

Primary investigator: Shirleen Smith
(Heritage Branch, Vuntut
Gwitch'in Government)

Location: Fishing Branch River, Yukon

Limnological and paleolimnological assessments of Arctic lake ecosystems

Primary investigator: John Smol
(Queen's University)

Locations: Resolute area (Cornwallis Island), Prince Leopold Island and Tern Island, Nunavut

Establishing a meso-network of micrometeorological towers for eddy covariance measurements along a latitudinal permafrost and climate gradient across the Taiga Plains, Northwest Territories

Primary investigator: Oliver Sonnentag
(Université de Montréal)

Locations: Scotty Creek and Trail Valley Creek, Northwest Territories

Canada-Nunavut Geoscience Office 2014 Hall Peninsula Integrated Geoscience Project

Primary investigator: Holly Steenkamp
(Canada-Nunavut Geoscience Office)

Location: Opingivik (Baffin Island), Nunavut

The Lake Hazen watershed as a sentinel of Arctic environmental change

Primary investigator: Vincent St.Louis
(University of Alberta)

Location: Lake Hazen (Ellesmere Island), Nunavut

Land-water linkages and the fate of terrestrial carbon in aquatic ecosystems of the western Canadian Arctic

Primary investigator: Suzanne Tank
(York University)

Location: Inuvik, Northwest Territories

Elemental sulfur deposits as an astrobiological target: Formation and preservation of elemental sulfur in low-temperature springs relevant to Mars and Europa

Primary investigator: Alexis Templeton
(University of Colorado Boulder, United States)

Location: Borup Peninsula (Ellesmere Island), Nunavut

Radar remote sensing in support of winter road management

Primary investigator:

Joost van der Sanden
(Natural Resources Canada)

Location: Yellowknife, Northwest Territories

Northern Ellesmere Island in the Global Environment (NEIGE)

Primary investigator: Warwick Vincent
(Université Laval)

Location: Ward Hunt Island, Nunavut

**Beaufort Sea coastal geoscience -
Coastal Monitoring Program (Year 3)**

Primary investigator: Dustin Whalen
(Natural Resources Canada)

Location: Inuvik, Northwest Territories

**Microbial investigations of
permafrost and cold saline springs
in the High Arctic**

Primary investigator: Lyle Whyte
(McGill University)

Location: Expedition Fiord (Axel Heiberg),
Nunavut

**Hydroecology and biogeochemistry
of lakes in Wapusk National Park
(northern Manitoba)**

Primary investigator: Brent Wolfe
(Wilfred Laurier University)

Location: Churchill, Manitoba

**Great Slave TRACS (Transportation
Risk in the Arctic to
Climatic Sensitivity)**

Primary investigator: Stephen Wolfe
(Natural Resources Canada)

Location: Yellowknife, Northwest Territories

**Are boreal forests resilient to spruce
bark beetle outbreaks?**

Primary investigator: Carmen Wong
(Parks Canada)

Locations: Canada Creek and Lowell Lake,
Yukon

**Hydro-ecological responses of Arctic
tundra lakes to climate change and
landscape perturbation**

Primary investigator: Frederick Wrona
(Environment Canada)

Locations: Noell Lake and Upland Lakes
near Inuvik, Northwest Territories

**Studies of Paleozoic stratigraphy and
petroleum potential source rocks on
Akpatok Island**

Primary investigator: Shuxin Zhang
(Canada-Nunavut Geoscience Office)

Location: Akpatok Island, Nunavut

All-terrain vehicles at the
PCSP Ottawa warehouse



List of operations projects in 2014

Site visit by the Resolute Bay Area Co-management Committee (R-ACMC)

Primary investigator: Jason Akearok (Environment Canada)

Locations: Polar Bear Pass National Wildlife Area (Bathurst Island), Prince Leopold Island Bird Sanctuary (Prince Leopold Island) and Seymour Island Bird Sanctuary, Nunavut

Coats Island field inspections

Primary investigator: Erik Allain (Aboriginal Affairs and Northern Development Canada)

Location: Coral Harbour (Southampton Island), Nunavut

High Arctic environmental inspections

Primary investigator: Erik Allain (Aboriginal Affairs and Northern Development Canada)

Locations: Eureka and Grise Fiord (Ellesmere Island) and Resolute (Cornwallis Island), Nunavut

Qikiqtani field inspections

Primary investigator: Erik Allain (Aboriginal Affairs and Northern Development Canada)

Location: Arctic Bay (Baffin Island), Nunavut

Annual inspection and servicing of automatic weather stations and construction of a new site at Cape Providence

Primary investigator: Rich DeVall (Environment Canada)

Locations: Northern Axel Heiberg Island, Cape Liverpool (Bylot Island), Eureka (Ellesmere Island), Fort Ross (Somerset Island), Gateshead Island, Grise Fiord (Ellesmere Island), Isachsen (Ellef Ringnes Island), Rea Point (Melville Island) and northern Steffanson Island, Nunavut, and Aulavik National Park (Banks Island), Cape Providence (Melville Island) and Mould Bay (Prince Patrick Island), Northwest Territories

Sirmilik National Park operations

Primary investigator: Stephen Dicks (Parks Canada)

Locations: Aktineq Glacier, Borden Peninsula, Bylot Island Field Station and Qaersut Site (Bylot Island) and Elwin Inlet, Mala River and Arctic Bay (Baffin Island), Nunavut

Active Control Systems Eureka - Canadian Geodetic Survey

Primary investigator: Stuart Elson (Natural Resources Canada)

Location: Eureka (Ellesmere Island), Nunavut

Northern Watch Technology Demonstration Project

Primary investigator: Bruce Grychowski (Defence Research and Development Canada)

Location: Gascoyne Inlet (Devon Island), Nunavut

Quttinirpaaq National Park operations

Primary investigator: Emma Hansen (Parks Canada)

Locations: Tanquary Fiord and Lake Hazen (Ellesmere Island), Nunavut

ITK Inuit Executive Arctic training

Primary investigator: Stephen Hendrie (Inuit Tapiriit Kanatami)

Location: Kangiqsujuq, Quebec

VHF radio repeater installations

Primary investigator: Brian Koonoo (Mittimatalik Hunters and Trappers Association)

Locations: Baffin Bay and Milne Inlet (Baffin Island), Bylot Island and Emmerson Island, Nunavut

A researcher drives an all-terrain vehicle along the shoreline of Resolute Bay, Nunavut.

Nirjutiqavik Area Co-Management Committee site visit

Primary investigator: Lisa Pirie
(Environment Canada)

Location: Nirjutiqavik National Wildlife Area (Coburg Island), Nunavut

Auyuittuq National Park operations

Primary investigator: Delia Siivola
(Parks Canada)

Locations: Glacier Lake, June Valley, Maktak Fiord, northern Pangnirtung Fiord, Overlord Peak, Owl River, Summit Lake, Thor Peak, Ulu Peak and Windy Lake (Baffin Island), Nunavut

Ukkusiksalik National Park operations and research

Primary investigator: Monty Yank
(Parks Canada)

Locations: Repulse Bay, Douglas Harbour, Sila Lodge, Snowbank and Wager Bay, Northwest Territories

Ecosystem inventories, mapping, and monitoring of Auyuittuq National Park

Primary investigator: Paul Zorn
(Parks Canada)

Locations: Qikiqtarjuaq (Broughton Island) and Pangnirtung and various locations in Auyuittuq National Park (Baffin Island), Nunavut

Researchers examine a dried-up lake bed near Nettilling Lake on Baffin Island, Nunavut.





Annex

PCSP Advisory Board

The PCSP is a division of the Strategic Policy and Operations Branch (SPOB) at NRCan. The PCSP Advisory Board provides the Director General of SPOB with recommendations and advice regarding PCSP's services and operations. This board consists of Arctic experts from federal science agencies, academia, Aboriginal peoples' organizations and territorial governments.

PCSP Advisory Board Members 2014

Bernard Funston (Chair)

Northern Canada Consulting

Elizabeth Boston

Director

Mathematical, Environmental and
Physical Sciences Division
Natural Sciences and Engineering
Research Council of Canada

Drikus Gissing

Director, Wildlife Management
Department of Environment
Government of Nunavut

Siu-Ling Han

Head, Eastern Arctic Unit
Canadian Wildlife Service
Environment Canada

Donna Kirkwood

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Canada Excellence Research Chair and
Professor
Department of Geological Sciences
University of Manitoba

Brent Wolfe

Professor and Graduate Coordinator
Department of Geography and
Environmental Studies
Wilfred Laurier University

Robert Young

Division Manager
Aquatic Research Division
Freshwater Institute
Fisheries and Oceans Canada

Twin Otter aircraft at the
PCSP Resolute facility

PCSP Project Review Committee

The PCSP Project Review Committee (PRC) sets priorities for the allocation of direct, in-kind support from the PCSP for university-based projects. The PRC reviews and evaluates PCSP logistics requests on the basis of logistical feasibility, demonstrated scientific excellence, performance of previous field projects, quality of application and the involvement of students and northern residents in projects.

PCSP Project Review Committee Members 2014

Kathy Young (Chair)

Professor
Liberal Arts and Professional Studies
York University

David Corrigan

Section Head, Regional Geology
Geological Survey of Canada, Central Canada Division
Natural Resources Canada

Michael Kristjanson

Chief, Arctic Logistics Support
Polar Continental Shelf Program
Natural Resources Canada

Mark Mallory


Canada Research Chair and Associate Professor
Biology Department
Acadia University

Marc Meloche

Policy Advisor
Polar Knowledge Canada

Maribeth Murray

Executive Director, Arctic Institute of North America
Professor, Department of Archaeology
University of Calgary



Paleontologists explore
Devonian-age rock
layers in a prime fossil
discovery area on southern
Ellesmere Island.